



Eur päisches Pat ntamt Europ an Patent Office Office européen des brevets



11 Publication number:

0 656 412 A1

(12)

EUROPEAN PATENT APPLICATION published in accordance with Art. 158(3) EPC

21 Application number: 94906780.5

(a) Int. CI.6 C09K 19/42, C09K 19/08

2 Date of filing: 06.08.93

International application number: PCT/JP93/01106

(87) International publication number: WO 94/03558 (17.02.94 94/05)

Priority: 06.08.92 JP 229380/92

43 Date of publication of application: 07.06.95 Bulletin 95/23

Designated Contracting States:
GB

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LIQUID CRYSTAL COMPOSITION AND LIQUID CRYSTAL DISPLAY DEVICE MADE THEREFROM.

⑤ To provide a liquid crystal composition which has a low resistivity value, requires little electric current and has a low threshold drive voltage. A liquid crystal composition comprising at least one compound represented by general formula (II) wherein R₁ and R₂ represent each C₁-C₁₀ alkyl or C₂-C₁₀ alkenyl; S₁ to S₃ represent each -F, -CHF₂-, -OCHF₂, -CF₃ or -OCF₃; Z₁ and Z₂ represent each -Z₃-(C)₀-Z₄- (wherein Z₃ and Z₄ represent each -COO-, -CH₂CH₂-, -CH = CH-, ethynylene or a single bond), -COO-, -CH₂CH₂-, -CH = CH-, ethynylene or a single bond; A, B and C represent each a transcyclohexane or benzene ring; I, m and n represent each 0 or 1 provided that (I+m+n) ≥ 1; Z₅ represents -COO-, -CH₂CH₂-, -CH = CH- or a single bond; X₁ represents -F, -CF₃, -OCF₃, -CHF₂ or -CN; and Y₁ represents -H or -F.

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$$R_{1} - (A - Z_{1})_{\ell} - (B - Z_{2})_{m} - O S_{1}$$

$$S_{3}$$

$$R_{2} - H - Z_{5} - O X_{1}$$
(II)

$$R_2$$
— H — Z_5 — X_1 (II)

A liquid crystal composition and a liquid crystal display element using the same

Technical field

This invention relates to a liquid crystal composition for liquid crystal display elements and a liquid crystal display element using the same. More particularly, it relates to a nematic liquid crystal composition for a liquid crystal display of active matrix mode needing a high reliability, and a liquid crystal display element using the same.

Background art

As a theme for developing LCD (liquid crystal display device), two points of high precision (high contrast) and high speed response have been mentioned and researched including its display method. Among them, active matrix LCD (AM-LCD) including TFT (thin film transistor) has been advanced in the coloration and high precision and expected as a prospective winner of flat pannel display. However, its precision, response speed, picture surface size, etc. are far inferior to those of CRT which has been now most popularized among displays. Thus, vigorous research has been made on various elements constituting AM-LCD such as driving circuit, switching element, color filter, etc. Further, for liquid crystal materials, there have been required characteristics which can not be satisfied by conventional material systems having cyano group such as biphenyl systems, PCH systems, etc.

The present inventors have been considering that cyano group of terminal group or side chain has a certain mutual action upon ionic impurities present in display element to thereby have a bad influence upon current value, specific resistance value and hence display contrast, as disclosed in Japanese patent application laid-open No. Hei 2-289682. The drawback of the compound having cyano group consists in that, as a reduction of reliability in element, increase in the consumed current and reduction in the specific resistance are led, coupled with the driving current of two-terminal or three-terminal switch element, and display uneveness and reduction in the contrast are caused in the aspect of display characteristic.

For example, the contrast in TFT liquid crystal display element, shown in Fig. 1 is closely related to its signal voltage-retaining characteristic. This signal voltage-retaining characteristic of the liquid crystal display element refer to a degree of reduction in the signal voltage impressed onto TFT pixel containing liquid crystal within a definite frame period. In the case where the reduction in the signal voltage is absent, the contrast reduction does not occur. Further, as to the signal voltage-retaining characteristic, the lower the storage capacity (Cs) provided in parallel to the liquid crystal and the specific resistance of the liquid crystal (LC) or the signal voltage-retention, the worse the characteristic synergistically. In particular, when the specific resistance of the liquid crystal or the signal voltage-retention is lower than the lower limit values thereof, the signal voltage-retaining characteristic of the display element becomes exponentially worse, to thereby extremely reduce the contrast. In particular, in the case where no storage capacity is added for the reason of simplification of TFT production steps, or the like, contribution of the storage capacity cannot be expected, and as much, a liquid crystal composition having a high specific resistance or signal voltage-retention percentage is particularly required.

Herein, the signal voltage-retention of the liquid crystal composition having a large influence upon the signal voltage-retaining characteristic of the liquid crystal display element, and its measurement will be described. Using the circuit illustrated in Fig. 2, the signal voltage-retention of a cell having the liquid crystal composition filled therein is measured. The liquid crystal cell is measured using transparent electrodes and a glass substrate having an aligned membrane. Next, the waveform at the time of the measurement is illustrated in Fig. 3. The slant line portion refers to a practically observed wave form. The signal voltage-retention is expressed by the following equation:

Signal voltage-retention = $(V_1-t_1-t_2-V_2)/[(V_1)\times(t_1-t_2)]$

Herein, (V₁-t₁-t₂-V₂) shows the slant line portion in Fig. 3, (V₁) shows a source votage and (t₁-t₂) shows an impressed time. From such a viewpoint, a liquid crystal composition for AM-LCD composed only of compounds having no cyano group is disclosed in the above-mentioned Japanese patent application laid-open No. Hei 2-289682. Further, among compositions included in TN compositions disclosed in Japanese patent application laid-open No. Sho 63-61083, particularly compositions composed only of compounds having no cyano group have been so often used for AM-LCD.

However, LCDs using such compositions have high threshold voltage so that they are unsuitable to low voltage drive; hence 5V single drive is difficult; thus they are insufficient as a display which is a portable

device of battery drive. Further, they have drawbacks that the viscosity is so high that the response time is slow and the display grade in the display of moving picture is lowered and they cannot correspond to mouse or scroll in the OA use applications.

5 Disclosure of the Invention

The object of the present invention is to provide a liquid crystal composition having a relatively low viscosity and a low threshold voltage, while maintaining a high specific resistance value and a low consumption current, and a liquid crystal display device using the liquid crystal composition, which device has a high reliability and a relatively short response time and effects a low votage drive.

The present invention consists in a liquid crystal composition characterized by containing the following first component and second component, and a liquid crystal display element using the liquid crystal composition:

5 First component

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at least one member of compounds expressed by the formula (I):

$$R_1 - (A - Z_1)_{\ell} - (B - Z_2)_m - \bigotimes_{S_3}^{S_1} S_2$$
 (I)

wherein R₁ represents an alkyl group of 1 to 10 carbon atoms or an alkenyl group of 2 to 10 carbon atoms (one or two not-adjacent carbon atoms in these groups may be substituted by oxygen atom, -CO- or -COO-).

 S_1 , S_2 and S_3 may be the same or different and each represent fluorine atom, -CHF₂, -OCHF₂, -CF₃ or -OCF₃,

 Z_1 and Z_2 may be the same or different and each represent - Z_3 -(C)_n- Z_4 - (wherein Z_3 and Z_4 may be the same or different and each represent -COO-, -CH₂CH₂-, -CH = CH-, ethynylene group or single bond), -COO-, -CH₂CH₂-,-CH = CH-, ethynylene group or single bond,

A, B and C may be the same or different, and each represent trans-cyclohexane ring:

(one or two or more not-adjacent = CH2-s may be substituted by oxygen atom), or benzene ring

$$\langle \bigcirc \rangle$$

(one or two or more = CH-s in the ring may be substituted by nitrogen atom, and the hydrogen atoms in the ring may be substituted by fluorine atoms), and

1, m and n are the same or different, and each are 0 or 1 and $l + m + n \ge 1$),

Second component

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at least one member of compounds expressed by the formula (II):

$$R_2$$
— H — Z_5 — X_1 (II)

wherein R₂ represents an alkyl group of 1 to 10C or an alkenyl group of 2 to 10C (wherein one or two not-adjacent carbon atoms in these groups may be substituted by oxygen atom, -CO- or -COO-),

 Z_5 represents -COO-, -CH₂CH₂-, -CH = CH- or single bond,

x₁ represents F, -CF₃, -OCF₃ or -CHF₂,

Y₁ represents H or F

(wherein when Z₅ is single bond and X₁ is F, Y₁ cannot be H).

Brief description of the drawings

Fig. 1 shows an equivalent circuit of TFT display element.

Fig. 2 shows a circuit for measuring the signal voltage-retention of liquid crystal cell.

Fig. 3 shows the driving wave form and measured waveform at the time of measuring the signal voltageretention

Description of the Symbols

G Gate electrode

S Source electrode

D Drain electrode

C_s Storage capacity

LC Liquid crystal

V_G Scanning signal

V_s Display signal

V_c Direct current voltage

Embodiments of the Invention

As the first component of the present invention, at least one member of compounds expressed by the formula (I), but having the following definitions, are preferably used:

R₁ represents an alkyl group of 1 to 10C (wherein one or two not-adjacent carbon atoms in this group may be substituted by oxygen atom),

Z₁ and Z₂ may be the same or different and each represent -Z₃-(C)_n-Z₄ (wherein Z₃ and Z₄ may be the same or different and each represent -COO-, -CH₂CH₂-, -CH = CH- or single bond),

-COO-, -CH₂CH₂-, -CH = CH- or single bond,

A, B and C may be the same or different, and each represent trans-cyclohexane ring or benzene ring (H atoms in these rings may be sustituted by F atom) and other symbols are as defined above.

As the second component of the present invention, at least one of compounds expressed by the formula (II), but having the following definitions, are preferably used:

R₂ represents an alkyl group of 1 to 10C (wherein one or two not-adjacent carbon atoms in this group may be substituted by oxygen atom), and

X₁ represents -F, -CF₃ or -OCF₃ (other symbols are as defined above).

The above formula (I) can be concretely represented by the following formulas (Ia), (Ib) and (Ic): Formula (Ia):

$$R_1 - A - Z_{10} - \bigotimes_{s_3}^{s_1} s_2$$
 (Ia)

10 Formula (lb):

$$R_1 - A - Z_{11} - B - Z_{12} - \bigotimes_{S_3}^{S_1} S_2$$
 (Ib)

and Formula (Ic);

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$$R_1 - A - Z_{13} - B - Z_{14} - D - Z_{15} - \bigcirc_{S_3}^{S_1}$$
 (Ic)

In the above formula (la),

Z₁₀ represents -COO-, -CH₂CH₂-, -CH = CH-, ethynylene group or single bond (other symbols are as defined above).

In the above formula (lb),

 Z_{11} and Z_{12} may be the same or different, and each represent -COO-, -CH₂CH₂-, -CH = CH-, ethynylene group or single bond (other symbols are as defined above).

In the general formula (Ic),

 Z_{13} represents $-Z_{16}$ -(C)_n- Z_{17} -, -COO-, -CH₂CH₂-, -CH = CH-, ethynylene group or single bond,

 Z_{14} , Z_{15} , Z_{16} and Z_{17} may be the same or different, and each represent -COO-, -CH₂CH₂-, -CH = CH-, ethynylene group or single bond,

D has the same definition as that of A in the formula (I).

Preferable examples of compounds expressed by the formula (la) are as follows:

$$R_1 - H - CH_2 CH_2 - TFP$$
 (Ia1B)

$$R_1$$
—TFP (Ia1C)

$$R_1 \longrightarrow CH_2CH_2 - TFP$$
 (Ia1D)

$$R_1 \longrightarrow H \longrightarrow TFP$$
 (Ia1E)

$$R_1$$
—COO—TFP (Ia1F)

$$R_1$$
—CH=CH—TFP (Ia1G)

$$R_1 \longrightarrow CH = CH \longrightarrow TFP$$
 (Ia1H)

$$R_1 \longrightarrow C \supseteq C \longrightarrow TFP$$
 (Ia11)

$$R_1 \longrightarrow C \equiv C - TFP$$
 (Ia1J)

$$R_1 \longrightarrow DDP$$
 (Ia2A)

$$R_1$$
— CH_2 CH $_2$ —DDP (Ia2 B)

$$R_1 \longrightarrow DDP$$
 (Ia2C)

$$R_1 \longrightarrow CH_2CH_2 - DDP$$
 (Ia2D)

$$R_1 \longrightarrow COO \longrightarrow DDP$$
 (Ia2E)

$$R_1 \longrightarrow COO \longrightarrow DDP$$
 (Ia2F)

$$R_1 \longrightarrow H$$
 — CH=CH—DDP (Ia2G)

$$R_1 - CH = CH - DDP$$
 (Ia2H)

$$R_1 \longrightarrow C \equiv C - TFP$$
 (Ia2I)

$$R_1 \longrightarrow C \equiv C \longrightarrow TFP \qquad (Ia2J)$$

$$R_1 \longrightarrow H \longrightarrow DOP$$
 (Ia3A)

$$R_1 - \overline{H} - CH_2CH_2 - DOP$$
 (Ia3B)

$$R_1 \longrightarrow DOP$$
 (Ia3C)

$$R_1 \longrightarrow CH_2CH_2 \longrightarrow DOP$$
 (Ia3D)

$$R_1 \longrightarrow R_1 \longrightarrow DOP$$
 (Ia3E)

$$R_1$$
—COO—DOP (Ia3F)

$$R_1 - H$$
 — CH=CH—DOP (Ia3G)

$$R_1 \longrightarrow CH = CH - DOP$$
 (Ia3H)

$$R_1$$
— $C \equiv C$ — DOP (Ia3I)

$$R_1 \longrightarrow C \equiv C - DOP$$
 (Ia3J)

$$R_1 \longrightarrow H \longrightarrow TDP$$
 (Ia4A)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow TDP$$
 (Ia4B)

$$R_1 - O - TDP$$
 (Ia4C)

$$R_1 - CH_2CH_2 - TDP$$
 (Ia4D)

$$R_1 - \overline{H} - COO - TDP$$
 (Ia4E)

$$R_1$$
—COC—TDP (Ia4F)

$$R_1 - H - CH = CH - TDP$$
 (Ia4G)

$$R_1 \longrightarrow CH = CH - TDP$$
 (Ia4H)

$$R_1 - C = C - DOP$$
 (Ia4I)

$$R_1 - \bigcirc - C = C - DOP \qquad (Ia4J)$$

$$R_1 \longrightarrow TOP$$
 (Ia5A)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow TOP$$
 (Ia5B)

$$R_1$$
—TOP (Ia5C)

$$R_1 \longrightarrow CH_2CH_2 - TOP$$
 (Ia5D)

$$R_1 - \langle H \rangle - COO - TOP$$
 (Ia5E)

$$R_1 \longrightarrow COO \longrightarrow TOP$$
 (Ia5F)

$$R_1 - H$$
—CH=CH—TOP (Ia5G)

$$R_1$$
—CH=CH—TOP (Ia5H)

$$R_1 \longrightarrow C \equiv C - TOP$$
 (Ia51)

$$R_1 \longrightarrow C \equiv C \longrightarrow TOP$$
 (Ia5J)

$$R_1 \longrightarrow H \longrightarrow DTP$$
 (Ia6A)

$$R_1 - CH_2CH_2 - DTP$$
 (Ia6B)

$$R_1 \longrightarrow DTP$$
 (Ia6C)

$$R_1 - CH_2CH_2 - DTP$$
 (Ia6D)

$$R_1 - H - COO - DTP$$
 (Ia6E)

$$R_1 \longrightarrow COC \longrightarrow DTP$$
 (Ia6F)

$$R_1 \longrightarrow H \longrightarrow CH = CH \longrightarrow DTP$$
 (Ia6G)

$$R_1 \longrightarrow CH = CH - DTP$$
 (Ia6H)

$$R_1 \longrightarrow C \equiv C - DTP$$
 (Ia61)

$$R_1 \longrightarrow C \equiv C \longrightarrow DTP \qquad (Ia6J)$$

$$R_1 - H$$
 TTP (Ia7A)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow TTP$$
 (Ia7B)

$$R_1 \longrightarrow TTP$$
 (Ia7C)

$$R_1$$
— CH_2 CH₂—DTP (Ia7D)

$$R_1 - H$$
 COO - TTP (Ia7E)

$$R_1 - \bigcirc - COO - TTP$$
 (Ia7F)

$$R_1 \longrightarrow H$$
 — CH=CH—TTP (Ia7G)

$$R_1$$
 — CH=CH—TTP (Ia7H)

$$R_1$$
 $C \equiv C - TTP$ (Ia71)

$$R_1 \longrightarrow C \equiv C - TTP$$
 (Ia7J)

In the above formulas, TFP, DDP, DOP, TDP, TOP, DTP and TTP, each represent the following structural formulas:

TFP:

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$$- \bigcirc_{\mathbf{F}}^{\mathbf{F}}$$

DDP:

$$- \bigcirc_{\rm F}^{\rm F} {\rm CHF}_2$$

DOP:

55 TDP:

$$- \bigcirc_{\mathbf{F}}^{\mathbf{F}} \operatorname{cr}_{3}$$

TOP:

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$$\bigcirc$$
_F ∞ F₃

DTP:

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TTP:

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$$- \bigcirc_{\mathrm{OCF_3}}^{\mathrm{OCF_3}}$$

The above symbols have the same meanings in the following all formulas, and among the above compounds, the following compounds are preferably used:

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(Ia1A)

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(Ia1B)

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(Ia5A)

$$R_1 - H - CH_2CH_2 - TOP$$
 (Ia5B)

Among the above compounds, those wherein R_1 is a linear alkyl group or a linear alkoxy group of 1 to 10C are preferable, and those wherein R_1 is a linear alkyl group or a linear alkoxy group of 1 to 5C are particularly preferable.

Preferable concrete examples of compounds expressed by the above formulas (lb) are as follows:

$$R_1 - H - TFP$$
 (Ib1A)

 $R_1 - H - CH_2 CH_2 - H - TFP$ (Ib1B)

$$R_1 - H - CH_2CH_2 - TFP$$
 (Ib1C)

$$R_1$$
— CH_2 CH_2 — TFP (Ib1D)

$$R_1$$
— H — CH_2 CH $_2$ —TFP (Ib1E)

$$R_{1} \longrightarrow CH_{2}CH_{2} \longrightarrow TFP \qquad \text{(Ib1F)}$$

$$R_{1} \longrightarrow CH_{2}CH_{2} \longrightarrow TFP \qquad \text{(Ib1G)}$$

$$R_{1} \longrightarrow H \longrightarrow COO \longrightarrow TFP \qquad \text{(Ib1J)}$$

$$R_{1} \longrightarrow H \longrightarrow COO \longrightarrow TFP \qquad \text{(Ib1K)}$$

$$R_{1} \longrightarrow COO \longrightarrow TFP \qquad \text{(Ib1L)}$$

$$R_{1} \longrightarrow COO \longrightarrow TFP \qquad \text{(Ib1M)}$$

$$R_{1} \longrightarrow COO \longrightarrow TFP \qquad \text{(Ib1M)}$$

$$R_{1} \longrightarrow H \longrightarrow CH = CH \longrightarrow H \longrightarrow TFP \qquad \text{(Ib1N)}$$

$$R_1$$
—(Ib1Q)

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. (Ib1P)

$$R_1$$
— \bigcirc —CH=CH— \bigcirc —TFP (Ib1R)

$$R_1 \longrightarrow CH = CH - TFP$$
 (Ib1S)

$$R_1 \longrightarrow H \longrightarrow TFP$$
 (Ib1T)

$$R_{1} - H - C = C - TFP \qquad (Ib1U)$$

$$R_1 - \langle H \rangle - C \equiv C - \langle O \rangle - TFP \qquad (Ib1V)$$

$$R_1 \longrightarrow C \equiv C \longrightarrow TFP$$
 (Ib1W)

$$R_1 \longrightarrow C = C \longrightarrow TFP$$
 (Ib1X)

$$R_1 \longrightarrow C \supseteq C \longrightarrow TFP$$
 (Ib1Y)

$$R_1 \longrightarrow O \longrightarrow TFP$$
 (Ib1Z)

$$R_1 \longrightarrow H \longrightarrow DDP$$
 (Ib2A)

$$R_{1} \longrightarrow H \longrightarrow CH_{2}CH_{2} \longrightarrow H \longrightarrow DDP \qquad (Ib2B)$$

$$R_{1} \longrightarrow H \longrightarrow CH_{2}CH_{2} \longrightarrow DDP \qquad (Ib2C)$$

$$R_{1} \longrightarrow H \longrightarrow CH_{2}CH_{2} \longrightarrow DDP \qquad (Ib2D)$$

$$R_{1} \longrightarrow H \longrightarrow CH_{2}CH_{2} \longrightarrow DDP \qquad (Ib2E)$$

$$R_{1} \longrightarrow CH_{2}CH_{2} \longrightarrow DDP \qquad (Ib2E)$$

$$R_{1} \longrightarrow CH_{2}CH_{2} \longrightarrow DDP \qquad (Ib2F)$$

$$R_{1} \longrightarrow CH_{2}CH_{2} \longrightarrow DDP \qquad (Ib2G)$$

$$R_{1} \longrightarrow CH_{2}CH_{2} \longrightarrow DDP \qquad (Ib2G)$$

$$R_{1} \longrightarrow H \longrightarrow COO \longrightarrow DDP \qquad (Ib2H)$$

$$R_{1} \longrightarrow H \longrightarrow COO \longrightarrow DDP \qquad (Ib2J)$$

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(Ib2K)

$$R_1 - \bigcirc -COO - \bigcirc -DDP$$
 (Ib2L)

$$R_1 - \langle O \rangle - \langle O \rangle - COO - DDP$$
 (Ib2M)

$$R_1 - H - CH - CH - DDP$$
 (Ib2N)

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow CH=CH\longrightarrow DDP$$
 (Ib20)

$$R_1 \longrightarrow H \longrightarrow CH = CH \longrightarrow DDP$$
 (Ib2P)

$$R_1 \longrightarrow H \longrightarrow CH = CH \longrightarrow DDP$$
 (Ib2Q)

$$R_1 - O - CH = CH - O - DDP$$
 (Ib2R)

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$$R_1 \longrightarrow CH = CH - DDP$$
 (Ib2S)

$$R_1 \longrightarrow H \longrightarrow DDP$$
 (Ib2T)

$$R_1 \longrightarrow H \longrightarrow C \equiv C \longrightarrow DDP \qquad (Ib2U)$$

$$R_1 - H - C = C - O - DDP$$
 (Ib2V)

$$R_1 - H - C = C - DDP$$
 (Ib2W)

$$R_1 \longrightarrow C = C \longrightarrow DDP \qquad (Ib2X)$$

$$R_1 - \bigcirc - \bigcirc - C = C - DDP$$
 (Ib2Y)

$$R_1$$
 — DDP (Ib2Z)

$$R_1 - H - DOP$$
 (Ib3A)

$$R_1 - H - CH_2CH_2 - H - DOP$$
 (Ib3B)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow DOP$$
 (Ib3C)

$$R_1 \longrightarrow CH_2CH_2 \longrightarrow DOP$$
 (Ib3D)

$$R_1 - \langle H \rangle - \langle CH_2CH_2 - DOP \qquad (Ib3E)$$

$$R_1 \longrightarrow CH_2CH_2 \longrightarrow DOP$$
 (Ib3F)

$$R_1 \longrightarrow CH_2CH_2 - DOP$$
 (Ib3G)

$$R_1 \longrightarrow H \longrightarrow COO \longrightarrow H \longrightarrow DOP$$
 (Ib3H)

$$R_1 - \overline{H} - \overline{H} - COO - DOP$$
 (Ib31)

$$R_1 - H - COO - OOP$$
 (Ib3J)

$$R_1 - \overline{H} - \overline{O} - COO - DOP$$
 (Ib3K)

$$R_1 - \bigcirc - COO - \bigcirc - DOP$$
 (Ib3L)

$$R_{1} - \bigcirc - \bigcirc - \bigcirc - \bigcirc - \bigcirc - \bigcirc$$
 (Ib3M)

$$R_{1} - H - CH - CH - DOP \qquad (Ib3N)$$

$$R_1$$
— H — $CH=CH$ — DOP (Ib30)

$$R_1 - \overline{H} - CH = CH - \overline{O} - DOP$$
 (Ib3P)

$$R_1 \longrightarrow H \longrightarrow CH = CH \longrightarrow DOP$$
 (Ib3Q)

$$R_1 \longrightarrow CH = CH \longrightarrow DOP$$
 (Ib3R)

$$R_1 \longrightarrow CH = CH \longrightarrow DOP$$
 (Ib3S)

$$R_1 \longrightarrow H \longrightarrow DOP$$
 (1b3T)

$$R_{1} - \underbrace{H} - C \equiv C - DOP \qquad (Ib3U)$$

$$R_1 - H - C = C - DOP \qquad (Ib3V)$$

$$R_1 - \overline{H} - \overline{O} - C = C - DOP \qquad (Ib3W)$$

$$R_1 - \langle O \rangle - C = C - \langle O \rangle - DOP \qquad (Ib3X)$$

$$R_1 - \langle O \rangle - C = C - DOP \qquad (Ib3Y)$$

$$R_1$$
— \bigcirc — \bigcirc —DOP (Ib3Z)

$$R_1 - H - TDP$$
 (Ib4A)

$$R_1 - H - CH_2CH_2 - H - TDP$$
 (Ib4B)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow TDP$$
 (Ib4C)

$$R_1 - H - CH_2 CH_2 - O - TDP$$
 (Ib4D)

$$R_1 - H - CH_2CH_2 - TDP$$
 (Ib4E)

$$R_1 - CO - CH_2CH_2 - CO - TDP$$
 (Ib4F)

$$R_1 \longrightarrow CH_2CH_2 \longrightarrow TDP$$
 (Ib4G)

$$R_1 - H - COO - H - TDP$$
 (Ib4H)

$$R_1 \longrightarrow H \longrightarrow COO - TDP$$
 (Ib4I)

$$R_{1} \longrightarrow H \longrightarrow COO \longrightarrow TDP \qquad \text{(Ib4J)}$$

$$R_{1} \longrightarrow H \longrightarrow COO \longrightarrow TDP \qquad \text{(Ib4K)}$$

$$R_{1} \longrightarrow COO \longrightarrow TDP \qquad \text{(Ib4L)}$$

$$R_{1} \longrightarrow COO \longrightarrow TDP \qquad \text{(Ib4M)}$$

$$R_{1} \longrightarrow H \longrightarrow CH = CH \longrightarrow TDP \qquad \text{(Ib4N)}$$

$$R_{1} \longrightarrow H \longrightarrow CH = CH \longrightarrow TDP \qquad \text{(Ib4N)}$$

$$R_1 - \langle H \rangle - CH = CH - \langle O \rangle - TDP$$
 (Ib4P)

$$R_1 \longrightarrow CH = CH - TDP$$
 (Ib4Q)

$$R_1 \longrightarrow CH = CH \longrightarrow TDP$$
 (Ib4R)

$$R_1$$
 CH=CH—TDP (Ib4S)

$$R_1$$
— H — O — TDP (Ib4T)

$$R_1 \longrightarrow H \longrightarrow C \equiv C \longrightarrow TDP \qquad (Ib4U)$$

$$R_1 \longrightarrow H \longrightarrow C \equiv C \longrightarrow TDP$$
 (Ib4V)

$$R_1 - \overline{H} - \overline{O} - C = C - TDP$$
 (Ib4W)

$$R_{1} - \bigcirc - C = C - \bigcirc - TDP \qquad (Ib4X)$$

$$R_1 - \bigcirc - \bigcirc - C = C - TDP \qquad (Ib4Y)$$

$$R_1 - \bigcirc - \bigcirc - \bigcirc - \bigcirc$$
 (Ib4Z)

$$R_1 - H - TOP$$
 (Ib5A)

⁴⁵
$$R_1 - H$$
 $CH_2CH_2 - H$ TOP (Ib5B)

$$R_1$$
— H — CH_2 CH $_2$ —TOP (Ib5C)

$$R_1$$
— CH_2 CH_2 — O — TOP (Ib5D)

$$R_1$$
— CH_2CH_2 — TOP (Ib5E)

$$R_1 - CH_2CH_2 - CO$$
 TOP (Ib5F)

$$R_1 - O - CH_2CH_2 - TOP$$
 (Ib5G)

$$R_1 - H - COO - H - TOP$$
 (Ib5H)

$$R_1 \longrightarrow H \longrightarrow TOP$$
 (Ib51)

$$R_1$$
— H — COO — TOP (Ib5J)

$$R_1 - H - COO - TOP$$
 (Ib5K)

$$R_1 \longrightarrow COO \longrightarrow TOP$$
 (Ib5L)

$$R_1 \longrightarrow O \longrightarrow TOP$$
 (Ib5M)

$$R_1$$
—CH=CH—H—TOP (Ib5N)

$$R_1 \longrightarrow H \longrightarrow CH = CH \longrightarrow TOP$$
 (Ib50)

$$R_1 - H - CH - CH - TOP$$
 (Ib5P)

$$R_1 \longrightarrow H \longrightarrow CH = CH \longrightarrow TOP$$
 (Ib5Q)

$$R_1$$
—CH=CH—TOP (Ib5R)

$$R_1 \longrightarrow \bigcirc \longrightarrow CH = CH \longrightarrow TOP$$
 (Ib5S)

$$R_1 \longrightarrow TOP$$
 (Ib5T)

$$R_1$$
— H — $C \equiv C$ — TOP (Ib5U)

$$R_1 \longrightarrow R_1 \longrightarrow C \equiv C \longrightarrow TOP$$
 (Ib5V)

$$R_1 \longrightarrow C = C - TOP \qquad (Ib5W)$$

$$R_1 - \bigcirc C = C - \bigcirc TOP$$
 (1b5x)

 $R_1 - O - C = C - TOP$ (Ib5Y)

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 $R_1 - \langle O \rangle - \langle O \rangle - TOP$ (Ib52)

 $R_1 \longrightarrow H \longrightarrow DTP$ (Ib6A)

 $R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow DTP$ (Ib6B)

 $R_1 - H - CH_2CH_2 - DTP$ (Ib6C)

 $R_1 - H - CH_2CH_2 - O - DTP$ (Ib6D)

 $R_1 \longrightarrow CH_2CH_2 \longrightarrow DTP$ (Ib6E)

 $R_1 \longrightarrow CH_2CH_2 \longrightarrow DTP$ (Ib6F)

 R_1 — \bigcirc — CH_2CH_2 —DTP (Ib6G)

$$R_1 - H - COO - H - DTP$$
 (Ib6H)

$$R_1 - H - COO - DTP$$
 (Ib61)

$$R_1$$
— H — COO — DTP (Ib6J)

$$R_1 - \overline{H} - \overline{O} - COO - DTP$$
 (Ib6K)

$$R_1 - O - COO - DTP$$
 (Ib6L)

$$R_1 - O - COO - DTP$$
 (Ib6M)

$$R_1 - H$$
 CH=CH- H DTP (Ib6N)

$$R_1 - H - H - CH - CH - DTP$$
 (Ib60)

$$R_1$$
—CH=CH—O—DTP (Ib6P)

$$R_1 - H - CH - DTP$$
 (Ib6Q)

$$R_{1} - \bigcirc - CH = CH - \bigcirc - DTP \qquad (Ib6R)$$

$$R_{1} - \bigcirc - CH = CH - DTP \qquad (Ib6S)$$

$$R_{1} - \bigcirc + DTP \qquad (Ib6T)$$

$$R_{1} - \bigcirc + DTP \qquad (Ib6U)$$

$$R_{1} - \bigcirc + C = C - DTP \qquad (Ib6U)$$

$$R_{1} - \bigcirc + C = C - DTP \qquad (Ib6V)$$

$$R_{1} - \bigcirc + C = C - DTP \qquad (Ib6W)$$

$$R_{1} - \bigcirc + C = C - DTP \qquad (Ib6X)$$

$$R_{1} - \bigcirc + C = C - DTP \qquad (Ib6X)$$

$$R_1$$
—O—DTP (Ib6Z)

$$R_1 \longrightarrow H \longrightarrow TTP$$
 (Ib7A)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow H \longrightarrow TTP$$
 (Ib7B)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow TTP$$
 (Ib7C)

$$R_1 - H - CH_2CH_2 - CO - TTP$$
 (Ib7D)

$$R_1 - H - CH_2CH_2 - TTP$$
 (Ib7E)

$$R_1 \longrightarrow CH_2CH_2 \longrightarrow TTP$$
 (Ib7F)

$$R_1 \longrightarrow \bigcirc \longrightarrow CH_2CH_2 - TTP$$
 (Ib7G)

$$R_1 - H - COO - H - TTP$$
 (Ib7H)

$$R_1 - \overline{H} - \overline{H} - COO - TTP$$
 (Ib7I)

$$R_1$$
— H — COO — TTP (Ib7J)

$$R_1 - H - COO - TTP$$
 (Ib7K)

$$R_1$$
—COO—COO—TTP (Ib7L)

 $R_1 - \langle O \rangle - \langle O \rangle - COO - TTP$ (Ib7M)

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 $R_1 - H - CH - CH - TTP$ (Ib7N)

 $R_1 - H - H - CH = CH - TTP$ (Ib70)

 $R_1 - H - CH = CH - TTP$ (Ib7P)

 $R_1 - H - CH - TTP$ (Ib7Q)

 $R_1 - O - CH = CH - O - TTP$ (Ib7R)

 R_1 —O—CH=CH—TTP (Ib7S)

 $R_1 - H - TTP$ (Ib7T)

 $R_{1} - \overline{H} - C \equiv C - TTP \qquad (Ib7U)$

$$R_1 - H - C = C - O - TTP$$
 (Ib7V)

$$R_1 \longrightarrow H \longrightarrow C \equiv C \longrightarrow TTP$$
 (Ib7W)

$$R_1 - \langle O \rangle - C = C - \langle O \rangle - TTP \qquad (Ib7X)$$

$$R_1 \longrightarrow \bigcirc \bigcirc -C \equiv C - TTP$$
 (Ib7Y)

$$R_1 - O - TTP$$
 (Ib7z)

Among the above compounds, the following compounds are preferably used:

$$R_1 - H - TFP$$
 (Ib1A)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow TFP$$
 (Ib1B)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow TFP$$
 (Ib1c)

$$R_1 - H - CH_2CH_2 - TFP$$
 (Ib1D)

$$R_1 \longrightarrow H \longrightarrow COO-TFP$$
 (Ib1I)

$$R_1$$
—H—COO—TFP (Ib1K)

$$R_1 - H$$
 — $CH = CH - H$ — TFP (Ib1N)

$$R_1 - H - CH - CH - TFP$$
 (Ib10)

$$R_1 \longrightarrow H \longrightarrow TFP$$
 (Ib1T)

$$R_1 - H - C = C - TFP \qquad (Ib1W)$$

$$R_1 \longrightarrow C \longrightarrow TFP$$
 (Ib1Z)

$$R_1 \longrightarrow H \longrightarrow TOP$$
 (Ib5A)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow H \longrightarrow TOP$$
 (Ib5B)

$$R_1 - H - CH_2CH_2 - TOP$$
 (Ib5C)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow TOP$$
 (Ib5D)

$$R_1 - H - COO - TOP$$
 (1b51)

$$R_1$$
—H—O—COO—TOP (Ib5K)

$$R_1 - H - CH - CH - TOP$$
 (Ib5N)

$$R_1 \longrightarrow H \longrightarrow CH = CH - TOP$$
 (Ib50)

$$R_1 \longrightarrow TOP$$
 (Ib5T)

$$R_{1} - \underbrace{H} - C = C - TTP \qquad (Ib5W)$$

$$R_1 \longrightarrow \bigcirc \longrightarrow \bigcirc$$
 TOP (Ib5z)

Among the above compounds, the following compounds are preferably used:

$$R_1 \longrightarrow H \longrightarrow TFP$$
 (Ib1A)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow H \longrightarrow TFP$$
 (Ib1B)

$$R_1$$
— H — CH_2 CH $_2$ —TFP (Ib1C)

$$R_1 \longrightarrow H \longrightarrow TFP$$
 (Ib1T)

$$R_1 - H - H - TOP$$
 (Ib5A)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow H \longrightarrow TOP$$
 (Ib5B)

$$R_1$$
— H — CH_2CH_2 — TOP (Ib5C)

$$R_1$$
—TOP (Ib5T)

Among the above compounds, those wherein R₁ is a linear alkyl group or a linear alkoxy group of 1 to 10C, particularly those wherein R₁ is a linear alkyl group or a linear alkoxy group of 1 to 5C are preferable. Preferable concrete examples of compounds expressed by the above formula (Ic) are as follows:

$$R_1 - H - H - TFP$$
 (Ic1A)

$$R_1 - H - H - CH_2CH_2 - H - TFP$$
 (Ic1B)

$$R_1 - H - H - CH_2CH_2 - TFP$$
 (Ic1C)

$$R_1 \longrightarrow H \longrightarrow TFP$$
 (Ic1D)

$$R_1 - H - H - CH_2CH_2 - TFP$$
 (Ic1E)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow TFP$$
 (Ib1F)

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow H \longrightarrow TFP$$
 (Ic1G)

$$R_1 - H - H - DDP$$
 (Ic2A)

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow H \longrightarrow DDP$$
 (Ic2B)

$$R_1 - H - H - CH_2CH_2 - DDP$$
 (Ic2C)

$$R_1 \longrightarrow H \longrightarrow DDP$$
 (Ic2D)

$$R_1 - \langle H \rangle - \langle H \rangle - CH_2CH_2 - \langle O \rangle - DDP$$
 (Ic1E)

$$R_1 - H - O - CH_2CH_2 - DDP$$
 (Ic2F)

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow H \longrightarrow DDP \qquad (Ic2G)$$

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow DOP$$
 (Ic3A)

$$R_1 - H - CH_2CH_2 - H - DOP$$
 (Ic3B)

$$R_1$$
— H — H — CH_2 CH $_2$ —DOP (Ic3C)

$$R_1 \longrightarrow H \longrightarrow O \longrightarrow DOP$$
 (Ic3D)

$$R_1$$
— H — CH_2CH_2 — O — DOP (Ic3E)

$$R_1$$
 H CH_2 CH_2 DOP (Ic3F)

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow H \longrightarrow DOP$$
 (Ic3G)

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow TDP$$
 (Ic4A)

$$R_1$$
 H CH_2 CH_2 H TDP (Ic4B)

$$R_1$$
 H H CH_2CH_2 TDP (Ic4C)

$$R_1 - H - TDP$$
 (Ic4D)

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow CDP$$
 (Ic4E)

$$R_1$$
 H CH_2 CH_2 TDP (Ic4F)

$$R_1$$
 H H H TDP (Ic4G)

$$R_1 - H - H - TOP$$
 (Ic5A)

$$R_1 - H - CH_2CH_2 - H - TOP$$
 (Ic5B)

$$R_1$$
— H — H — CH_2 CH $_2$ —TOP (Ie5C)

$$R_1 - H - O - TOP$$
 (Ic5D)

$$R_1$$
— H — CH_2 CH $_2$ — O —TOP (Ic5E)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow TOP$$
 (Ic5F)

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow H \longrightarrow TOP$$
 (Ic5G)

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow DTP$$
 (Ic6A)

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow DTP$$
 (Ic6B)

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow DTP$$
 (Ic6C)

$$R_1 - \langle H \rangle - \langle H \rangle - \langle O \rangle - DTP$$
 (Ic6D)

$$R_1 - H - CH_2CH_2 - O - DTP$$
 (Ic6E)

$$R_1 - H - CH_2CH_2 - DTP$$
 (Ic6F)

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow DTP$$
 (Ic6G)

$$R_1 - H - H - TTP \qquad (Ic7A)$$

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow TTP$$
 (Ic7B)

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow TTP$$
 (Ic7C)

$$R_1 \longrightarrow H \longrightarrow TTP$$
 (Ic7D)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow TTP$$
 (Ic7E)

$$R_1 - H - H - C - CH_2CH_2 - TTP$$
 (Ic7F)

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow TTP$$
 (Ic7G)

Among the above compounds, the following compounds are preferably used:

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow TFP$$
 (Ic1A)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow H \longrightarrow TFP$$
 (Ic1B)

$$R_1 - H - CH_2CH_2 - CO - TFP$$
 (Ic1E)

$$R_1 \longrightarrow H \longrightarrow H \longrightarrow TOP$$
 (Ic5A)

$$R_1 - H - CH_2CH_2 - H - TOP$$
 (Ic5B)

$$R_1 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow TOP$$
 (Ic5E)

Among the above compounds, those wherein R_1 is a linear alkyl group or a linear alkoxy group of 1 to 10C, particularly those wherein R_1 is a linear alkyl group or a linear alkoxy group of 1 to 5C, are preferable.

The compounds expressed by the formula (I) are known as described in for example, Japanese patent application laid-open No. Sho 2-233626, and have characteristics of a high clearing point, a broad liquid crystal phase, a low viscosity and a relatively large dielectric anisotropy.

Among the compounds expressed by the formula (I), those wherein R₁ of the above formulas (Ib1A), (Ib1B) and (Ib1C) is a linear alkyl group of 3C (propyl group) are named IA₃, IB₃ and IC₃, and mixtures of these compounds with commercially available cyclohexanebenzonitrile group liquid crystal ZLI-1132 (made by E. Merck; hereinafter abbreviated to "Commercially available liquid crystal 32") are each named IA₃(P), IB₃(P) and IC₃(P), and the values of physical properties thereof are shown in Table 1.

Table 1

5			I A ₃ (P)	I B, (P)	I C ₃ (P)	Commer- cially available L.C.32
10	weight	I As	15			
15	part by	I B ₃		15		
	Mixture p	I C.			15	
20	Mi	Commercially available L.C.32	8 5	8 5	85	100
25	S	M.P. Mp(°C)	<-20	<-20	<-20	
30	Characteristics	Clearing point Cp(°C)	72.4	71.0	73.4	72.4
35	Char	Refractive anisotropy ∆n	0.130	0.125	0.129	0.137

The values in the parentheses refer to extrapolated values.

In addition, the numeral values in the parentheses of Table 1 were sought according to extraporation method, regarding that the values of physical properties of the mixtures are additive as regards the mixing weight.

Preferable concrete examples of the compounds expressed by the above formula (II), as the second component of the present invention are as follows:

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$$R_2$$
— CH_2 CH $_2$ —DFP (II A)

$$R_2$$
— H —DFP (II B)

$$R_2$$
— H — COO — F (I C)

$$R_2$$
— H — CF_3 (II D)

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$$R_2 - H - CF_3$$
 (II E)

$$R_2$$
— H — CH_2 CH_2 — G — F ([] G)

$$R_2$$
— CH_2 CH $_2$ — CF_3 (II H)

$$R_2 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow OCF_3$$
 (II I)

$$R_2$$
— H — O — CHF_2 (II J)

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$$R_2$$
— H — O CHF $_2$

 R_2 — CH_2 CH $_2$ CH $_2$ (II L)

 R_2 — CH_2 CH $_2$ —OCH F_2

 R_2 —H—COO—DFP

In the above formulas, R_2 is as defined above, and DFP represents the following formula:

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30 Among the above compounds, the following compounds are preferably used:

$$R_2$$
— H — CH_2 CH $_2$ — DFP

$$R_2$$
—H—DFP (II B)

$$R_2 \longrightarrow H \longrightarrow COO \longrightarrow F$$
 (II C)

$$R_2$$
— H — CF_3

Among the above compounds, those wherein R₂ is a linear alkyl group or an alkoxy group of 1 to 10C are preferable, and particularly those wherein R₂ is a linear alkyl group or a linear alkoxy group of 1 to 7C are preferable.

Among the compounds expressed by the formula (II), compounds wherein R₂ of the above formulas (IIA), (IIB) and (IIC) is a linear alkyl group of 5C (pentyl group) are respectively named IIA₅, IIB₅ and IIC₅, and the values of physical properties (extrapolated values) in the case where these compounds were dissolved in a quantity of 15% by weight in a commercially available cyclohexanebenzonitrile group liquid crystal ZLI-1083 (made by E. Merck: hereinafter abbreviated to "commercially available liquid crystal 83") are shown in Table 2.

Table 2

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IIAs IIB_5 IIC₅ NI (• C) -47.3 -52.7 9.3 η20 (CP) -8.2 -12.2 -8.2 0.033 Δn 0.007 -0.007 10.9 10.9

As apparent from Table 2, any of these compounds exhibit physically common properties such as a positive dielectric anisotropy of 9.6 to 10.9, a low viscosity of -8.2 to -12.2 cp, etc. Further, they have a very low specific resistance. For practical use, the proportion of these compounds used in the liquid crystal composition of the present invention is suitably 30% by weight, taking into account, lowering of clearing point accompanying the addition of these compounds, etc.

The compounds expressed by the formula (II) are known as disclosed in for example, Japanese patent application laid-open Nos. Hei 2-111734 and Sho 61-207347 and WO 8902884.

The liquid crystal composition of the present invention may contain the following third component besides the above first component and second component:

Third component

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At least one member of compounds expressed by the formula (III):

$$R_3 - H - Z_6 - A - Z_7 - Q - X_2$$
 (III)

wherein

R₃ is as defined by R₁ of the formula (I),

A is as defined by A of the formula (I),

Z₆ represents -COO-, -CH₂CH₂-, -CH = CH- or single bond,

Z₇ represents -COO-, -CH₂CH₂-, -CH = CH-, ethynylene group or single bond,

X₂ represents F, -CF₃, -OCF₃, -CHF₂ or -OCHF₂, and

Y₂ is as defined by Y₁ of the formula (II).

Namely, one of the liquid crystal compositions of the present invention contains the above first component, second component and third component.

As the third component of the present invention, there is preferably used at least one of compounds of the formula (III) wherein

R₃ represents an alkyl group of 1 to 10C (wherein one or two not-adjacent carbon atoms in the group may be substituted by oxygen atom).

A represents trans-cyclohexane ring or benzene ring (the hydrogen atom in these rings may be substituted by F), and

X₂ represents F atom or -CF₃ (other symbols are as defined above).

Preferable concrete examples of the compounds expressed by the above formula (III) are as follows:

 $R_3 - H - H - DFP$ (III A)

$$R_3$$
— H — CH_2 CH $_2$ — H — DFP ($III B$)

$$R_3$$
— H — O —DFP (III C)

$$R_3$$
— H — CH_2CH_2 — DFP ($\underline{\text{II}}$ D)

$$R_3 \longrightarrow H \longrightarrow H \longrightarrow F$$
 (III E)

$$R_3$$
 \longrightarrow F ($\coprod F$)

$$R_3 - H - CH_2CH_2 - H - CO - F$$
 (III G)

$$R_3 - H - H - CH_2CH_2 - F$$
 (III H)

$$R_3 - H - CF_3$$
 (III I)

$$R_3 \longrightarrow H \longrightarrow O \longrightarrow OCF_3$$
 (III J)

$$R_3$$
 H H CHF_2 $(III K)$

$$R_3$$
— H — O — CHF_2 ($III L$)

$$R_{3} \longrightarrow H \longrightarrow CF_{3} \qquad (\text{II M})$$

$$R_{3} \longrightarrow H \longrightarrow CF_{3} \qquad (\text{II N})$$

$$R_{3} \longrightarrow H \longrightarrow CHF_{2} \qquad (\text{II O})$$

$$R_{3} \longrightarrow H \longrightarrow CHF_{2} \qquad (\text{II O})$$

$$R_3 - H - CH_2CH_2 - H - CF_3$$
 (II Q)

$$R_3$$
— H — CH_2 CH_2 — H — O — OCF_3 (II R)

$$R_3$$
 H CH_2 CH_2 H CHF_2 (III S)

$$R_3$$
— CH_2 CH $_2$ — H — $OCHF_2$ (III T)

$$R_3$$
 H CH_2 CH_2 CF_3 (III U)

$$R_3 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow OCF_3$$
 (II V)

$$_{\rm R_3}$$
 — $_{\rm H}$ — $_{\rm CH_2CH_2}$ — $_{\rm CHF_2}$ ($\rm III$ W)

$$R_3$$
— H — CH_2 CH $_2$ — O CHF $_2$ (III X)

$$R_3 - H - CH - CH - DFP$$
 ($III Y)$

$$R_3$$
— H — $CH=CH$ — H — O — F

Among the above compounds, the following compounds are preferably used:

$$R_3 \longrightarrow H \longrightarrow DFP$$
 (III A)

$$R_3$$
— H — CH_2 CH $_2$ — H —DFP (\blacksquare B)

$$R_3 - H - O - DFP$$
 (III C)

$$R_3 - H - H - CH_2CH_2 - DFP$$
 (III D)

$$R_3 \longrightarrow H \longrightarrow G \longrightarrow F$$
 ($\coprod E$)

$$R_3$$
— H — $CH=CH$ — H — DFP ($\square Y$)

Among the compounds, those wherein R_3 represents a linear alkyl group or a linear alkoxy group of 1 to 10C, particularly those wherein R_3 represents a linear alkyl group or a linear alkoxy group of 1 to 5C are preferably used.

Compounds expressed by the formula (III) are known as disclosed in for example, Japanese patent application laid-open Nos. Sho 57-64626, Sho 57-154135, Sho 62-25683 and Sho 57-185230, USP 4,797,228 and USP 4,820,443, and have a high clearing point, a positive dielectric anisotropy and a low viscosity and a high specific resistance, for three-ring system.

The liquid crystal composition of the present invention may contain the following fourth component, besides the first, second and third components:

Fourth component

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At least one of compounds expressed by the formula (IV):

$$R_4 - R_5 - R_5$$
 (IV)

wherein R₄ and R₅

may be the same or different, and each are as defined by R₁ in the formula (I),

A is as defined by A of the formula (I),

Z₈ represents -COO-, -CH₂ CH₂-, -CH = CH- or single bond, and

 Z_9 represents -COO-, -CH₂CH₂-, -CH = CH-, ethynylene group or single bond.

Namely, one of the liquid crystal compositions of the present invention contains the above first component, second component, third component and fourth component.

As the fourth component of the present invention, there is preferably used at least one member of compounds of the formula (IV) wherein

 R_4 and R_5 may be the same or different and each are an alkyl group of 1 to 10C (wherein one or two not-adjacent carbon atom may be substituted by oxygen atom), and

A represents trans-cyclohexane ring or benzene ring (the hydrogen atom of these rings may

be substituted by fluorine atom) (other symbols are as defined above).

Preferable concrete examples of compounds expressed by the formula (IV) are as follows:

$$R_4$$
 H R_5 (IV A)

$$R_4 - H - CH_2CH_2 - C = C - R_5$$
 (IV B)

$$R_4 \longrightarrow F$$

$$C \equiv C \longrightarrow R_5 \qquad (W C)$$

$$R_4$$
— H — CH_2 CH_2 — H — O — R_5 (IV D)

$$R_4$$
— H — CH_2 CH_2 — O — R_5 (IV E)

$$R_4$$
— H — CH_2CH_2 — O — R_5 (IV F)

 R_4 —H—O— R_5

 $R_4 \longrightarrow \bigcirc \longrightarrow R_5$ (IV H)

 R_4 —H—COO—H— R_5

 R_4 —H—COO— R_5 (IV J)

 R_4 \longrightarrow COO \longrightarrow R_5 (IV K)

 $R_{4} - H - OCO - H - R_{5}$ (IV L)

 $R_4 \longrightarrow R_5$ (IV M)

Among the above compounds, the following compounds are preferably used:

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$$R_4$$
— H — G — R_5 (IV A)

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$$R_4$$
— CH_2CH_2 — $C=C$ — $C=C$ — R_5 (IV B)

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$$R_4$$
— H — $C \equiv C$ — R_5 (IV C)

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$$R_4$$
 \rightarrow R_5 (IV G)

Among the above compounds, those wherein R_4 and R_5 each represent a linear alkyl group or a linear alkoxy group of 1 to 10C, particularly those wherein R_4 and R_5 each represent a linear alkyl group or a linear alkoxy group of 1 to 5C, are particularly used.

The compounds expressed by the above formula (IV) are known as disclosed in for example, Japanese patent application laid-open Nos. Sho 57-165328 and Sho 63-152334 and DE 2927277, and have characteristics of a high clearing point, a low viscosity and a neutral dielectric anisotropy. For practical uses, the proportion of these compounds used in the liquid crystal composition of the present invention is suitably 30% by weight or less, taking into account, the increase in the threshold voltage accompanying the addition of these compounds, etc.

• The liquid crystal composition of the present invention may contain the following fifth component, besides the above first component, second component, third component and fourth component:

5 Fifth component

At least one member of compounds expressed by the formula (V):

R6-A-Z10-B-R7

A and B

wherein

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R₆ and R₇ may be the same or different and each are as defined by R₁ of the formula (I),

A is as defined by A of the formula (I), B is as defined by B of the formula (I),

Z₁₀ represents -COO-, -CH₂CH₂-, -CH = CH-, ethynylene group or single bond.

Namely, one of the liquid crystal composition of the present invention contains the above first component, second component, third component, fourth component and fifth component.

As the fourth component of the present invention, there is preferably used at least one member of compounds of the above formula (V) wherein

R₆ and R₇ may be the same or different and each represent an alkyl group of 1 to 10C (one or two not-adjacent carbon atoms in this group may be oxygen atom, -CO- or -COO-),

may be the same or different, and each represent trans-cyclohexane ring or benzene ring (one or two = CH-s in these rings may be substituted by nitrogen atom, and the hydrogen

(one or two = CH-s in these rings may be substituted by nitrogen atom, and the hydrogen atom in the rings may be substituted by fluorine atom) (other symbols are as defined above).

Preferable concrete examples of the compounds expressed by the formula (V) are as follows:

$$R_{6} \longrightarrow R_{7} \qquad (VA)$$

$$R_{6} \longrightarrow R_{7} \qquad (VB)$$

$$R_{6} \longrightarrow R_{7} \qquad (VC)$$

$$R_{6} \longrightarrow R_{7} \qquad (VC)$$

$$R_{6} \longrightarrow R_{7} \qquad (VD)$$

$$R_{6} \longrightarrow R_{7} \qquad (VE)$$

$$R_{6} \longrightarrow R_{7} \qquad (VF)$$

$$R_{6} \longrightarrow R_{7} \qquad (VF)$$

$$R_{6} \longrightarrow R_{7} \qquad (VF)$$

$$R_{6} \longrightarrow R_{7} \qquad (VG)$$

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(VJ)

$$R_6 - H - CH_2CH_2 - H - R_7$$
 (VK)

 $R_6 \longrightarrow H \longrightarrow CH_2CH_2 \longrightarrow R_7$ (VL)

Among the above compounds, the following compounds are preferably used:

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$$R_6 \longrightarrow R_7$$
 (VA)

$$R_6 - H - R_7$$
 (VB)

$$R_6$$
 CCH₂ \rightarrow H \rightarrow R₇ (VC)

$$R_6 - H - COOR_7$$
 (VD)

$$R_6 - H - COO - R_7$$
 (VF)

$$R_6 - COO - COO - R_7$$
 (VG)

$$R_6 - \langle O \rangle - C = C - \langle O \rangle - R_7$$
 (VH)

Among the above compounds, those wherein R_6 and R_7 each represent a linear alkyl group or a linear alkoxy group of 1 to 10C, particularly those wherein R_6 and R_7 each represent a linear alkyl group or a linear alkoxy group of 1 to 5C, are preferably used.

The compounds expressed by the formula (V) are known as disclosed for example, in Japanese patent application laid-open Nos. Sho 59-70624, Sho 58-167535, Sho 58-170733 and Sho 61-5031, DE 2636684 and DE 2429093, and have a very low viscosity, a neutral dielectric anisotropy and a superior compatibility, and much contribute to making the specific resistance of the compositions higher. The practically used proportion of these compounds in the liquid crystal composition of the present invention is suitably 25% by

weight or less, taking into account, the increase in the threshold voltage, etc. accompanying the addition of these compounds.

The liquid crystal composition of the present invention may contain another liquid crystal compound or liquid crystalline compound besides the above first component to fifth component, in a suitable quantity within a range wherein the object of the present invention is not damaged, in order to control the threshold voltage in the voltage-transmittance characteristic, the liquid crystal temperature range, the refractive anisotropy, the dielectric anisotropy, the viscosity, etc. Concrete examples of these compounds are as follows:

$$R \longrightarrow H \longrightarrow COO \longrightarrow H \longrightarrow R'$$
 $R \longrightarrow H \longrightarrow COO \longrightarrow H \longrightarrow R'$
 $R \longrightarrow H \longrightarrow COO \longrightarrow H \longrightarrow R'$
 $R \longrightarrow H \longrightarrow COO \longrightarrow H \longrightarrow R'$
 $R \longrightarrow H \longrightarrow COO \longrightarrow H \longrightarrow R'$
 $R \longrightarrow H \longrightarrow COO \longrightarrow H \longrightarrow R'$

$$R-H-O-O-CEC-O-R$$

$$R \longrightarrow COO \longrightarrow COO \longrightarrow CH_2CH_2 \longrightarrow R$$

$$R \longrightarrow H \longrightarrow COO \longrightarrow O \longrightarrow CH_2CH_2 \longrightarrow H \longrightarrow R$$

$$R - H - COO - CH_2CH_2 - H - R'$$

$$R - H - C = C - R'$$

$$R \longrightarrow CH_2CH_2 \longrightarrow R$$

$$R--\bigcirc$$
- $COO-\bigcirc$ - R'

$$R - H - COO - O - CH_2CH_2 - H - R$$

$$R \longrightarrow H \longrightarrow CO \longrightarrow CH_2CH_2 \longrightarrow R'$$

$$R \longrightarrow H \longrightarrow H \longrightarrow CN$$

$$R-(H)-CH_2CH_2-(O)-CN$$

In the above formulas, R and R' each represent an alkyl group or an alkoxy group of 1 to 10C. The above compounds can be used alone or in an adequate combination of two or more kinds.

In the liquid crystal composition of the present invention containing the above first component and second component, the proportions of the first component and the second component used, each are 15 to 97% by weight and 3 to 30% by weight, preferably 30 to 90% by weight and 5 to 25% by weight, based

upon the total weight of the composition, and the total quantity of these components is at least 50% by weight, preferably at least 60% by weight.

As another embodiment of the present invention, the proportions of the first component, second component and third component used in the liquid crystal composition containing the first component, second component and third component are respectively 15 to 97% by weight, 3 to 30% by weight and 5 to 90% by weight, preferably 30 to 90% by weight, 5 to 25% by weight and 5 to 55% by weight, based upon the total weight of the liquid crystal composition, and the total quantity of these components is at least 50% by weight, preferably at least 60% by weight.

As still another embodiment of the present invenion, the proportions of the first component, second component, third component and fourth component used in the liquid crystal composition containing the first component, second component, third component and fourth component, are respectively 15 to 97% by weight, 3 to 30% by weight, 5 to 90% by weight and 3 to 30% by weight, preferably 30 to 90% by weight, 5 to 25% by weight, 5 to 55% by weight and 5 to 25% by weight, based upon the total weight of the composition, and the total quantity of these components is at least 50% by weight, preferably at least 70% by weight.

As further still another embodiment of the present invention, the proportions of the first component, second component, third component, fourth component and fifth component used in the liquid crystal composition containing the first component, second component, third component, fourth component and fifth component, are respectively 15 to 97% by weight, 3 to 30% by weight, 5 to 90% by weight, 3 to 30% by weight and 3 to 25% by weight, preferably 30 to 90% by weight, 5 to 25% by weight, 5 to 55% by weight, 5 to 25% by weight and 3 to 20% by weight, based upon the total weight of the composition, and the total quantity of these components is at least 50% by weight, preferably at least 70% by weight.

The liquid crystal composition of the present invention has a characteristic of a low threshold voltage, while retaining a high specific resistance, a low consumed current and a low viscosity. Thus, the liquid crystal composition of the present invention can be preferably used for liquid crystal display element, particularly for AM-LCD.

The liquid crystal display element of the present invention using the liquid crystal composition having the above characteristics has characteristics of a high contrast, a high reliability, a rapid response speed and further a capability of low voltage drive, etc. Thus, it can correspond to a high-grade, moving picture display, mouse and scroll, and it is possible to provide a liquid crystal display device for OA which is easy in the battery drive.

Example

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The present invention will be described in more detail by way of Examples, but it should not be construed to be limited thereto.

In addition, the definitions and measurement methods of various characteristics herein are as follows:

Threshold voltage (voltage transmittance characteristic)

The threshold voltage refers to a voltage (absorption percentage 10%) wherein the transmittance of light in the optical direction perpendicular to the indicated surface of display, and it is shown by Vth.

Specific resistance

The specific resistance refers to a value obtained by filling liquid crystals in a liquid cell (type: LE-21) made by Ando Electric Corporation), followed by impressing a dielectric current of 10V with PA meter (made by HP Corporation) and a DC voltage source (type: HP 4140B), and the initial value is represented by ρ_0 (0 cm) and a value obtained after heating test at 80 °C (1,000 hours) is represented by ρ_H . The liquid crystals for the heating test was preserved in a pylex glass vessel at 80 °C in nitrogen gas atmosphere. The 1,000 hours as the heating test time is considered to be generally suitable as a time showing a value close to saturation value.

Signal voltage retention

The signal voltage retention was measured using the circuit shown in Fig. 2, as described above, and calculated according to the following formula:

Signal voltage retention = $(V_1-t_1-t_2-V_2)/[(V_1)\times(t_1-t_2)]$

wherein (V₁-t₁-t₂-V₂) shows an oblique line portion of Fig. 3,

 V_1 represents a source voltage, and (t_1-t_2) represents an impressed time. In addition, the measurement of the signal voltage retension was carried out at room temperature (20 ° C) and 80 ° C.

In addition, as to the reliability test, the light-resistance test, particularly ultraviolet rays-resistance test, was not carried out, considering that the photo-deterioration problem could be solved due to recent development of ultraviolet rays-cutting filter.

All of the liquid crystal compositions in Examples and Comparative examples were prepared using the same recipe. "%" refers to "% by weight".

Comparative example a

Herein, the first component (compound of the formula (I) was not used. A liquid crystal composition consisting of the following components and its characteristics were measured and the results are shown in Table 3:

as the compounds of the formula (II), (a difluorophenylcyclohexane)

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12.0 %

as the compounds of the formula (III), (difluorophenylcyclohexanes)

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$$C_2H_5$$
— H — DFP

11.7 %

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$$C_3H_7-H-H-DFP$$

11.7 %

40

$$C_5H_{11}$$
 \rightarrow H \rightarrow H \rightarrow DFP

11.7 %

(difluorophenylcyclohexylethanes)

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$$C_{2}H_{5} - H - CH_{2}CH_{2} - H - DFP$$

$$11.2 \%$$

$$C_{3}H_{7} - H - CH_{2}CH_{2} - H - DFP$$

$$C_{5}H_{11} - H - CH_{2}CH_{2} - H - DFP$$

$$11.2 \%$$

$$(difluorobiphenylcyclohexanes)$$

$$20 \qquad C_{2}H_{5} - H - O-DFP$$

$$5.0 \%$$

$$C_{5}H_{11} - H - O-DFP$$

$$10.0 \%$$

$$C_{5}H_{11} - H - O-DFP$$

$$C_{5}H$$

Herein, the first component (compound of the formula (I)) was not used.

A liquid crystal composition consisting of the following components and its characteristics were measured, and the results are shown in Table 3:

As the compound of the formula (II),

(a difluorophenylcyclohexane)

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10.0%

as the compounds of the formula (III), (difluorophenylbicyclohexanes)

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2.0 %

as the compound of the formula (V), (a phenylcyclohexane)

 C_3H_7 \longrightarrow OC_2H_5

10 Comparative example c

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Herein, the first component (compound of the formula (I)) and the second component (compound of the formula (II)) were not used.

A liquid crystal composition consisting of the following compounds were prepared and its characteristics were measured, and the results are shown in Table 3:

as the compounds of the formula (III), (difluorophenylcyclohexanes)

$$C_2H_5 - H \rightarrow H \rightarrow DFP$$

16.7 %

10.0 %

$$c_3H_7 - H - H - DFE$$

16.7 %

$$C_5H_{11} - \overline{H} - \overline{H} - \overline{DFP}$$

16.7 %

(a fluorophenylbicyclohexane)

$$C_3H_7$$
— H — H — G — F

6.0 %

(bicyclohexylcarboxylic acid fluorophenyl esters),

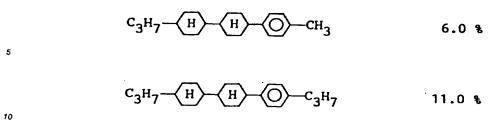
$$C_3H_7 - H - COO - F$$

6.0 %

$$C_5H_{11}$$
 $-\langle H \rangle$ $-\langle H \rangle$ $-coo-\langle O \rangle$ $-I$

6.0 %

as the compounds of the formula (IV), (phenylbicyclohexanes),



as another compound,

20 Comparative example d

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Herein, the first component (compound of the formula (I)) was not used.

A liquid crystal composition consisting of the following compounds was prepared and its characteristics were measured, and the results are shown in Table 3:

as the compounds of the formula (II),

$$C_2H_5$$
— CH_2CH_2 —DFP 10.0 %

$$C_5H_{11}$$
— CH_2CH_2 — DFP 10.0 %

as the compounds of the formula (III),

$$C_2H_5$$
 H CH_2CH_2 DFP 28.0 %

$$C_4H_9$$
 H CH_2CH_2 DFP 6.0 %

$$C_5H_{11}$$
 H CH_2CH_2 DFP 6.0 %

$$C_2H_5$$
 \rightarrow CH_2CH_2 \rightarrow DFP 22.0 %

$$C_3H_7$$
— H — CH_2CH_2 — H — DFP 8.4 %

$$C_4H_9 - H - CH_2CH_2 - H - DFP$$
 9.6 %

Comparative example e

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Herein, the first component (compounds of the formula (I)) was not used.

A liquid crystal composition consisting of the following compounds was prepared and its characteristics were measured, and the results are shown in Table 3:

As the compound of the formula (II),

as the compounds of the formula (III),

$$C_5H_{11}$$
 H DFP 8.3 %

Comparative example f

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Herein, the second component (compound of the formula (II)) was not used. A liquid crystal composition consisting of the following compounds was prepared and its characteristics were measured, and the results are shown in Table 3: as the compounds of the formula (I),

13.0 %

12.0 %

as the compounds of the formula (III),

8.0 % 50

$$C_5H_{11}$$
 H O DFP 6.0 %

$$C_2H_5$$
 H O OCF_3 10.0 %

$$C_4H_9 \longrightarrow H \longrightarrow OCF_3$$
 8.0 %

$$C_5H_{11}$$
 \rightarrow H \rightarrow O \rightarrow OCF_3 12.0 %

as other components,

$$C_5H_{11}$$
 H F 12.0 %

EP 0 656 412 A1

Table 3

Example))	Comparative examples	examples		
Characteristics		Д	U	e.	ၿ	ţ
Clearing point NI (°C)	82.0	95.7	106.8	78.8	74.3	78.0
Refractive anisotropy An	0.085	0.100	0.098	0.081	0.082	0.084
Viscosity (20°C) n ₂₀ (cp)	25.4	23.7	20.6	28.0	23.8	17.2
Dielectric anisotropy $\Delta\varepsilon$	4.7	3.5	2.9	8.8	4.5	5.4
Threshold voltage V _{th} (V)	1.92	2.14	2.41	2.03	2.18	1.87
Initial specific resistance po (ncm)	1.3 × 1014	9.8 × 1013	4.6 × 1013	1.6× 1014	9.9 × 1014	1.4 × 1014
Specific resistance after heated $ ho_{ m H}$ (Ncm)	4.1 × 1012	1.7 × 1012	8.3 × 10 ¹¹	4.1× 10'z	1.6 × 1012	3.5 × 1012
Signal voltage retention (25°C) (%)	98.7	98.4	98.1	98.4	98.4	98.2
Signal voltage retention (80°C) (%)	98.6	98.2	87.2	98.2	98.2	98.1

Comparative example g

Herein, the second component (compounds of the formula (II)) was not used.

A liquid crystal composition consisting of the following compounds were prepared, and its characteristics were measured, and the results are shown in Table 4:

As the second component (compounds of the formula (II)),

 C_5H_{11} H TFP 12.0 % C_3H_7 H TFP 14.0 %

$$c_{5}H_{11}$$
 H O OCF_3 12.0 %

as other compounds,

$$C_5H_{11}$$
 H F 12.0 % C_7H_{15} H F 8.0 %

40	35	30	25	15	10	5
			Table 4	•		
Example	S	Comparative example		Example]e	
Characteristics		ь		8	4	9
Clearing point NI (°C)	<u> </u>	77.0	42.9	46.0	71.3	91.1
Refractive anisotropy An	c	0.085	0.059	0.058	0.070	0.085
Viscosity (20°C) _{n20} (cp)	G.	17.7	22.2	21.6	19.2	17.9
Dielectric anisotropy Δε	ω	5.4	6.1	6.1	5.1	4.7
Threshold voltage V _{th} (V)	5	1.83	1.07	1.17	1.77	1.98
Initial specific resistance ρ0 (Ωcm)	<u> </u>	1.5 × 1014	2.5 × 1014	2.1 × 1014	1.6 × 1014	3.1 × 1014
Specific resistance after heated ρ_{H} ($\Omega \mathrm{cm}$)		4.1 × 1012	9.2 × 1012	6.7 × 1012	5.0 × 1012	9.6 × 10 ¹¹
Signal voltage (25°C) (%) retention	(49	98.2	98.7	98.5	98.2	98.4
Signal voltage (80°C) (%) retention) G	98.1	98.4	88:3	98.1	98.0

Example 1

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A liquid crystal composition consisting of the following compounds was prepared, and its characteristics were measured, and the results are shown in Table 4: as the compounds of the formula (I),

C₂H₅—H—TFP 25.0 %

23.0

 C_3H_7 H TFP 35.0 %

C₅H₁₁—(H)—TFP 18.0 %

C₇H₁₅—(H)—DFP 12.0 %

30 Example 2

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• A liquid crystal composition consisting of the following compounds was prepared, and its characteristics were measured, and the results are shown in Table 4:

C₂H₅—(H)—TFP 26.0 %

C₃H₇—H—H—TFP 26.0 %

 $C_{F}H_{11} - \overline{H} - \overline{H}$ TFP 26.0 %

and as the compounds of the formula (II),

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as the compound of the formula (II),

Example 3

A liquid crystal composition consisting of the following compound was prepared:

as the compounds of the formula (I),

$$C_{2}H_{5} \longrightarrow H \longrightarrow H \longrightarrow TFP$$

$$C_{3}H_{7} \longrightarrow H \longrightarrow H \longrightarrow TFP$$

$$C_{5}H_{11} \longrightarrow H \longrightarrow TFP$$

$$C_{5}H_{11} \longrightarrow H \longrightarrow TFP$$

$$C_{6}H_{7} \longrightarrow H \longrightarrow H \longrightarrow TFP$$

$$C_{7}H_{7} \longrightarrow H \longrightarrow H \longrightarrow TOP$$

as the compounds of the formula (II),

$$C_7H_{15}$$
 DFP 12.0 %

 C_7H_{15} DFP 12.0 %

 C_5H_{11} CH₂CH₂-DFP 10.0 %

Example 4

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A liquid crystal composition consisting of the following compounds was prepared, and its characteristics were measured, and the results are shown in Table 4:

as the compounds of the formula (I),

$$C_2H_5 - H - H - TFP$$

10.0 %

$$C_3H_7 - H - H - TFI$$

10.0 %

$$C_5H_{11} - \overline{H} - \overline{H} - \overline{TFP}$$

10.0 %

as the compounds of the formula (II)

$$^{\text{C}_5\text{H}_{11}}$$
 \leftarrow $^{\text{H}}$ \rightarrow $^{\text{CH}_2\text{CH}_2}$ \rightarrow $^{\text{DFP}}$

10.0 %

$$C_5H_{11}$$
 $-\langle H \rangle$ $-coo$ $-\langle O \rangle$ $-E$

7.5 %

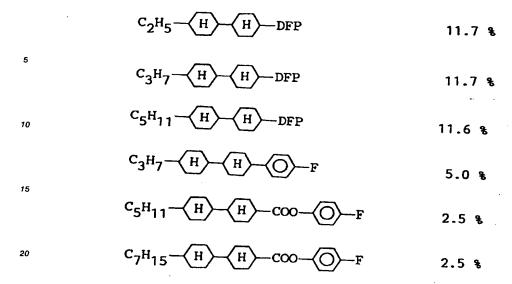
$$C_7H_{15}$$
 $-COO$ $-F$

7.5 %

as the compounds of the formula (III),

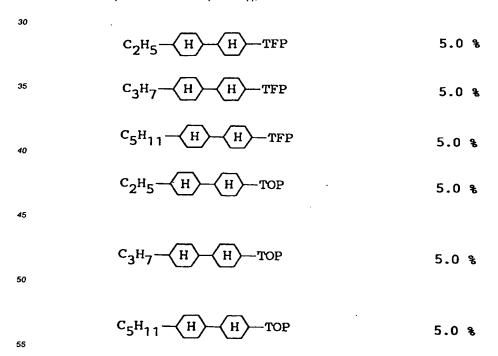
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25 Example 5

A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the component (I),



as the compounds of the formula (II),

$$C_5H_{11}$$
 H COO F 2.5 %

Example 6

A liquid crystal composition consisting of the following compounds was prepared, and its characteristics
were measured, and the results are shown in Table 4:
as the compounds of the formula (I),

as the compounds of the formula (IV),

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5.0 %

$$C_3H_7$$
 H CH_2CH_2 $C \equiv C$ $C \equiv C$ C_2H_5 5.0 %

Example 7

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A liquid crystal composition consisting of the following compounds was prepared: 20 as the compound of the formula (I),

$$C_5H_{11}$$
 H TFP 5.0 %

$$C_2H_5$$
— H — TOP 5.0 %

$$C_3H_7 \longrightarrow H \longrightarrow TOP$$
 5.0 %

$$C_5H_{11}$$
 TOP 5.0 %

as the compounds of the formula (II),

$$C_7H_{15}$$
 H DFP 10.0 % C_5H_{11} H CH_2CH_2 DFP 5.0 % as the compounds of the formula (III), C_2H_5 H DFP 10.0 %

as the compounds of the formula (IV),

$$c_3H_7$$
 H C_3H_7 7.0 %

55 Example 8

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A liquid crystal composition consisting of the following compounds was prepared, and its characteristics were measured, and the results are shown in Table 5:

as the compounds of the formula (I),

$$_{5}$$
 $C_{2}H_{5}$ H TFP

7.0 %

$$C_3H_7 - H - TFF$$

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20

35

45

7.0 %

$$C_3H_7 - H - H - TFF$$

7.0 %

$$c_3H_7-H$$

5.0 %

$$C_5H_{11}$$
 \longrightarrow H \longrightarrow TFF

4.0 %

30 as the compounds of the formula (II),

10.0 %

$$C_5H_{11}$$
— CH_2CH_2 —DFP

9.0 %

as the compounds of the formula (III),

$$C_2H_5 - \overline{H} - \overline{O} - DFF$$

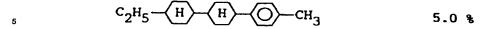
5.0 %

5.0 %

$$C_5H_{11}$$
 \rightarrow H \rightarrow O \rightarrow DFE

10.0 %

as the compounds of the formula (IV),



15
 C_3H_7 H O OCH_3 5.0 %

as the compound of the formula (V),

$$C_3H_7$$
 \longrightarrow OC_2H_5 10.0 %

Example 9

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A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the formula (I),

as the compounds of the formula (III),

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9.0 %

 C_5H_{11} — CH_2CH_2 —DFP

as the compounds of the formula (IV)

as a compound of the formula (V)

$$c_3H_7$$
— H — O — oc_2H_5

Example 10

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A liquid crystal composition consisting of the following compounds was prepared, and its characteristics were measured, and the results are shown in Table 5: as the compounds of the formula (I),

as a compound of the formula (II),

as the compounds of the formula (III),

$$C_3H_7 - H - DFP$$
 5.0 %

$$C_5H_{11}$$
 H DFP 5.0 %

$$C_2H_5 \longrightarrow CH_2CH_2 \longrightarrow DFP$$
 2.0 %

$$C_3H_7$$
— H — CH_2CH_2 — H — DFP

C₅H₁₁—(H)—CH₂CH₂—(H)—DFP 2.0 %

as the compounds of the formula (IV),

30 as the compound of the formula (V)

$$_{35}$$
 CH₃OCH₂—(H)— $_{C_3H_7}$ 5.0 %

		1	т	1							-,	
5	Table 5		14	77.1	0.097	16.5	g. 6	2.02	1.9 × 1014	5.0 × 1012	98.4	98.2
10		ole	12	89.0	0.108	18.9	4.2	2.09	1.0 × 1014	4.0 × 1012	98.4	98.1
15 20		Example	10	74.4	0.079	18.0	5.5	1.80	3.0 × 1014	8.2 × 1012	98.3	98.1
25			∞	71.1	0.082	17.4	3.9	2.04	1.4 × 1014	4.1 × 1012	98.3	98.0
30		Example	/ 8	NI (°C)	anisotropy An	3) n ₂₀ (cp)	anisotropy Δε	age V _{th} (V)	ic ρ _ο (Ωcm)	cance PH (Acm)	(25°C) (8)	(8) (3,08)
35			Characteristics	ring point	Refractive ani	Viscosity (20°C)	Dielectric ani	Threshold voltage	itial specific resistance	ecific resistance after heated PH	gnal voltage retention	gnal voltage retention
40			Char	Clearing	Refra	Visc	Diele	Thres	Initial resis	Specific after 1	Signal reter	Signal reter

Example 11

A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the formula (I),

55

The state compound of the formula (II),

$$C_{2}H_{5} \longrightarrow H \longrightarrow H \longrightarrow TFP$$

$$10.0 \%$$

$$10.0 \%$$

$$10.0 \%$$

$$10.0 \%$$

$$10.0 \%$$

$$10.0 \%$$

$$10.0 \%$$

$$10.0 \%$$

$$10.0 \%$$

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H-CH₂CH₂-DFP

16.0 %

as the compounds of the formula (III),

35

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45

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$$C_2H_5$$
— H — DFP 5.0 %

$$C_3H_7$$
 H DFP 5.0 %

$$C_2H_5 \longrightarrow CH_2CH_2 \longrightarrow DFP$$
 2.0 %

as the compounds of the formula (IV)

as the compound of the formula (V),

Example 12

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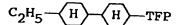
40

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A liquid crystal composition consisting of the following compounds was prepared, and its characteristics were measured, and the results are shown in Table 5:

as the compounds of the formula (I),



10.0 %

 $C_3H_7-\overline{H}-\overline{H}-TFP$

10.0 %

$$C_5H_{11} - H - H - TFF$$

10.0 %

as the compounds of the formula (II),

$$C_7H_{15}$$
—H—DFP

5.0 %

$$C_5H_{11}$$
 H COO F

2.5 %

2.5 %

as the compounds of the formula (III),

$$C_2H_5-H$$

4.5 %

$$C_3H_7 - \langle H \rangle - \langle O \rangle - DFF$$

4.5 %

as the compound of the formula (V),

C₃H₇—(H)—(O)—OC₂H₅ 10.0 %

Example 13

A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the formula (I),

55

$$C_2H_5$$
— H — TFP 5.0 %

$$C_3H_7$$
— H — TFP 5.0 %

$$C_5H_{11}$$
— H — TFP 5.0 %

$$C_2H_5$$
 H TOP 5.0 %

as the compounds of the formula (II),

$$C_{5}H_{11}$$
 TOP 5.0 %

$$C_7H_15H$$
—DFP 5.0 %

as the compounds of the formula (III),

as a compound of the formula (V),

55

10.0 %

Example 14

5

A liquid crystal composition consisting of the following compounds was prepared, and its characteristics were measured, and the results are shown in Table 5:

as the compounds of the formula (I),

$$C_3H_7$$
 H TFP 10.0 %

as the compounds of the formula (II),

30
 $^{\text{C}_3\text{H}_7}$ $^{\text{H}}$ $^{\text{CF}_3}$ 3.0 %

as the compounds of the formula (III),

$$C_2H_5$$
— H — CH_2CH_2 — H — DFP

$$C_3H_7$$
— H — CH_2CH_2 — H — DFP 2.0 %

$$C_5H_{11}$$
 \rightarrow CH_2CH_2 \rightarrow H \rightarrow DFP 4.0 %

$$C_3H_7$$
 H COO F 0.8 %

$$C_5H_{11}$$
 H COO F 0.8 %

as the compounds of the formula (IV),

$$C_3H_7 - H - CH_2CH_2 - C - C - C_2H_5$$
 5.0 %

5

10

$$c_3H_7$$
— H — $C=C$ — C_3H_7

5.0 %

as the compounds of the formula (V),

15

$$C_3H_7$$
 O OC_2H_5

5.0 %

20

$$C_3H_7$$
— H — O — C_2H_5

3.0 %

25

$$C_3H_7 - H - H - C_4H_6$$

4.0 %

as another compound,

35

30

$$C_5H_{11}$$
 H C_3H_7

3.0 %

40 Example 15

A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the formula (I),

45

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as the compounds of the formula (III),

55

2.2 %

$$C_2H_5$$
— CH_2CH_2 — H —DFP 4.0 %

$$C_5H_{11}$$
 \rightarrow CH_2CH_2 \rightarrow H \rightarrow DFP 4.0 %

as the compounds of the formula (IV),

$$C_3H_7$$
 H CH_2CH_2 $C \equiv C$ C_2H_5 5.0 %

as the compounds of the formula (V),

$$C_3H_7$$
 $-\langle H \rangle$ $-\langle O \rangle$ $-C_2H_5$ 3.0 %

as another compound,

$$C_5H_{11}$$
 H O H C_3H_7 3.0 %

Example 16

A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the formula (I),

$$C_{5}H_{11} - H - CH_{2}CH_{2} - TFP \qquad 10.0 \text{ } 8$$

$$C_{3}H_{7} - H - CH_{2}CH_{2} - H - TFP \qquad 12.0 \text{ } 8$$

$$C_{5}H_{11} - H - CH_{2}CH_{2} - H - TFP \qquad 12.0 \text{ } 8$$

$$C_{5}H_{11} - H - CH_{2}CH_{2} - TFP \qquad 12.0 \text{ } 8$$

$$C_{5}H_{11} - H - CH_{2}CH_{2} - TFP \qquad 12.0 \text{ } 8$$

$$C_{5}H_{11} - H - CH_{2}CH_{2} - TFP \qquad 10.0 \text{ } 8$$

$$C_{5}H_{11} - H - CH_{2}CH_{2} - TFP \qquad 10.0 \text{ } 8$$

$$C_{5}H_{11} - H - CH_{2}CH_{2} - TFP \qquad 3.0 \text{ } 8$$

$$C_{5}H_{11} - H - CH_{2}CH_{2} - H - TFP \qquad 3.0 \text{ } 8$$

$$C_{3}H_{7} - H - H - CH_{2}CH_{2} - H - TFP \qquad 3.0 \text{ } 8$$

$$C_{3}H_{7} - H - H - CH_{2}CH_{2} - H - TFP \qquad 3.0 \text{ } 8$$

$$C_{3}H_{7} - H - H - CH_{2}CH_{2} - H - TFP \qquad 3.0 \text{ } 8$$

$$C_{3}H_{7} - H - H - CH_{2}CH_{2} - H - TFP \qquad 3.0 \text{ } 8$$

$$C_{3}H_{7} - H - H - CH_{2}CH_{2} - H - TFP \qquad 3.0 \text{ } 8$$

$$C_{3}H_{7} - H - H - CH_{2}CH_{2} - H - TFP \qquad 3.0 \text{ } 8$$

55

10.0 %

8.0 %

Example 17

A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the formula (I),

$$C_5H_{11}$$
— H —TOP

8.0 %

10

5

$$C_5H_{11}$$
— CH_2CH_2 — TOP

10.0 %

15

$$C_3H_7$$
— CH_2CH_2 — H — TOP

12.0 %

20

*2*5

$$C_5H_{11}$$
— CH_2CH_2 — H — TOP

12.0 %

30

$$C_3H_7$$
— H — H — CH_2CH_2 — TOP

12.0 %

35

$$C_5H_{11}$$
 H H CH_2CH_2 TOP

12.0 %

40

$$C_3H_7$$
— H — O — TOP

10.0 ₺

45

$$C_5H_{11}$$
— H — O — TOP

8.0 %

50

$$C_3H_7 - H - H - TOP$$

3.0 %

55

$$C_3H_7$$
 H CH_2CH_2 H TOP

3.0 %

as the compound of the formula (II),

$$C_7H_{15} - H \rightarrow DFP$$

10.0 %

Example 18

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A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the formula (I),

$$C_5H_{11} - \overline{H}$$
 TFP

8.0 %

$$C_2H_5 - H$$
 TFP

10.0 %

$$c_3H_7 - \overline{H} - \overline{H} - \overline{TFH}$$

10.0 %

$$C_5H_{11}$$
— H — H — TFP

10.0 %

3.0 %

$$C_3H_7$$
 H CH_2CH_2 TOE

3.0 %

as the compounds of the formula (II),

$$C_7H_{15}$$
— H —DFP

8.0 %

$$C_5H_{11}$$
— CH_2CH_2 — DFP

6.0 %

as the compounds of the formula (III),

9.3 %

$$C_3H_7 - \overline{H} - \overline{H} - DFF$$

9.4 %

$$C_5H_{11}$$
 H H DFI

9.3 %

as the compounds of the formula (IV),

$$C_3H_7 - \overline{H} - \overline{H} - \overline{O} - C_3H_7$$

9.0 %

$$C_3H_7$$
 H CH_2CH_2 $C \equiv C$ C_2H_5

5.0 %

Example 19

A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the formula (I),

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$$C_2H_5 \longrightarrow H \longrightarrow DDP$$

10.0 %

CH W P

10.0 %

$$C_5H_{11} - \overline{H} - \overline{H} - DDP$$

10.0 %

as the compounds of the formula (II),

50

$$C_{5}H_{11} \xrightarrow{H} CH_{2}CH_{2} \xrightarrow{DFP}$$

$$C_{5}H_{11} \xrightarrow{H} COO \xrightarrow{F}$$

$$C_{5}H_{11} \xrightarrow{H} COO \xrightarrow{F}$$

$$C_{7}H_{15} \xrightarrow{H} COO \xrightarrow{F}$$

$$7.5 %$$

as the compounds of the formula (III),

$$C_{2}H_{5} \longrightarrow H \longrightarrow H \longrightarrow DFP$$

$$11.7 \%$$

$$C_{3}H_{7} \longrightarrow H \longrightarrow H \longrightarrow DFP$$

$$11.6 \%$$

$$C_{5}H_{11} \longrightarrow H \longrightarrow F$$

$$11.6 \%$$

$$C_{5}H_{11} \longrightarrow H \longrightarrow F$$

$$2.5 \%$$

Example 20

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A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the formula (I),

as the compounds of the formula (III),

55

$$C_5H_{11}$$
 H COO F 2.5 %

Example 21

A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the formula (I),

30
 $^{\text{C}}_{2}^{\text{H}}_{5}$ $\stackrel{\text{H}}{\smile}$ $\stackrel{\text{TDP}}{\longrightarrow}$ 10.0 %

as the compounds of the formula (II),

as the compounds of the formula (III),

₅ C₂H₅ H H DFP 11.7 %

10 C₃H₇—(H)—DFP 11.7 %

 C_5H_{11} H DFP 11.6 %

20 C₃H₇—(H)—(F)—F 5.0 %

 C_5H_{11} H COO F 2.5 %

³⁰ C₇H₁₅ ← H ← COO ← F 2.5 %

35 Example 22

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A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the formula (I),

 $C_2H_5 \longrightarrow H \longrightarrow TFP$ 14.2 %

C₃H₇—H—TFP 14.2 %

C₅H₁₁—(H)—TFP 14.2 %

55 C₂H₅—H—H—TFP 5.0 %

as a compound of the formula (II),

as the compounds of the formula (III)

$$C_2H_5$$
— H — DFP

$$C_5H_{11}$$
 H DFP 4.8 %

$$C_2H_5$$
— CH_2CH_2 — H —DFP 2.0 %

$$C_3H_7$$
 — CH_2CH_2 — CH_2 — CH_2

$$C_3H_7 - H - H - F$$
 3.8 %

as the compounds of the formula (IV),

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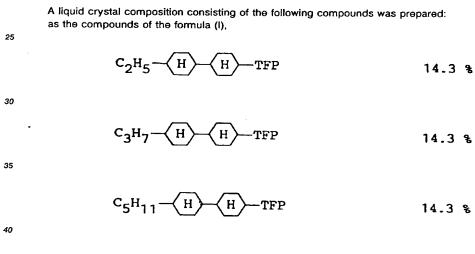
$$C_3H_7$$
 H CH_2CH_2 $C=C$ C_2H_5 4.7 % as a compound of the formula (V), CH_3CH_2 H C_3H_7 4.7 % 4.7 %

The characteristic values of the liquid crystal composition were as follows: N-I = $80 \cdot C$, $\Delta \epsilon = 5.7$, $\Delta n = 0.079$, viscosity = 20.2 cp and $V_{10} = 1.8$ volt.

Example 23

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45



$$C_3H_7$$
 H H TFP 4.0 %

as the compounds of the formula (II),

as the compounds of the formula (III),

$$C_2H_5$$
— CH_2CH_2 — H —DFP 3.0 %

$$C_3H_7$$
 H CH_2CH_2 H DFP 1.5 %

$$C_5H_{11} - \overline{H} - \overline{COO} - \overline{O} - F$$
 0.6 %

as the compounds of the formula (IV),

$$C_3H_7$$
 H CH_2CH_2 $C \equiv C$ $C \equiv C$ C_2H_5 3.7 %

$$C_3H_7$$
 H $C \equiv C$ $C \equiv C$ C_3H_7 3.8 %

as the compounds of the formula (V),

$$c_3H_7$$
 \rightarrow OC_2H_5 3.8 %

$$c_3H_7$$
 H C_2H_5 2.2 %

$$C_3H_7 \longrightarrow H \longrightarrow C_4H_9$$
 3.0 %

as another compound,

The characteristic values of this liquid crystal composition were as follows: N-I = 84 $^{\circ}$ C, Δ n = 0.093, viscosity = 19.9 cp Δ e = 5.1, V = 1.79 V.

Example 24

A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the formula (I),

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as the compounds of the formula (IV),

55

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3.5 %

 C_3H_7 \longrightarrow CH_2CH_2 \longrightarrow $C\equiv C$ \longrightarrow C_2H_5 3.6 %

The clearing point of this liquid crystal composition was N-I = 94.2 °C.

Example 25

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A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the formula (I),

C₂H₅—(H)—TFP 14.2 %
$$C_{3}H_{7}$$
—(H)—TFP 14.2 %

$$C_5H_{11}$$
 H H TFP 14.2 %

40
 $^{C}2^{H}5$ \longrightarrow ^{C}H \longrightarrow TFP 5.0 %

as a compound of the formula (II),

as the compounds of the formula (III),

4.7 %

50

55

as a compound of the formula (V),

сн₃осн₂--

Example 26

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A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the formula (I),

 C_2H_5 —H—TFP

14.3 %

 $C_3H_7 - H - H - TFI$

14.3 %

C₅H₁₁—H—TFF

14.3 %

C3H7-H-CH2CH2-C=C-C-TFF

4.0 %

as the compounds of the formula (II),

30 C_H_-

 C_3H_7 —H—O— CF_3

2.3 %

 $C_5H_{11} - H - CH_2CH_2 - H - DF$

7.7 %

 C_5H_{11} H $-\infty$

1.8 %

C-H- - H - COO

2.0 %

as the compounds of the formula (III),

55

40

45

$$C_2H_5$$
— H — CH_2CH_2 — H — DFP 3.0 %

$$C_3H_7 - H - CH_2CH_2 - H - DFP$$
 1.5 %

$$C_5H_{11}$$
 — CH_2CH_2 — H — DFP 3.0 %

as the compounds of the formula (IV),

$$C_3H_7$$
 \leftarrow CH_2CH_2 \leftarrow $C=C$ \leftarrow C_2H_5 3.7 &

as the compounds of the formula (V),

$$C_3H_7$$
 \longrightarrow OC_2H_5 3.8 %

$$c_3H_7$$
— H — c_2H_5

$$C_3H_7$$
 H C_4H_9 3.0 %

as another compound,

Example 27

A liquid crystal composition consisting of the following compounds was prepared: as the compounds of the formula (I),

$$C_2H_5$$
 H TFP 15.5 %

$$C_3^{H}_7$$
 H H TFP 15.5 %

 $C_5^{H}_{11}$ H H TFP 15.5 %

 $C_2^{H}_5$ H $C_2^{H}_2$ H TFP 3.8 %

as the compounds of the formula (II),

$$C_7H_{15}$$
 H DFP 7.1 % C_5H_{11} H CH_2CH_2 DFP 3.5 %

30 as the compound of the formula (III),

$$C_2H_5$$
 H DFP 7.1 %

 C_3H_7 H DFP 7.1 %

 C_5H_{11} H DFP 7.1 %

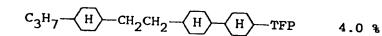
as the compounds of the formula (IV),

55

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15

3.5 %



as the compounds of the formula (II),

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$$C_3H_7$$
— H — CF_3

$$C_5H_{11}$$
— CH_2CH_2 —DFP 7.7 %

1.8 %

$$C_{7}H_{15} - H - COO - F$$

$$C_{7}H_{15} - H - COO - F$$
2.0 %

$$C_{7}H_{15} - H - COO - F$$
2.0 %

$$C_{2}H_{5} - H - CH_{2}CH_{2} - H - DFP$$
3.0 %

$$C_{3}H_{7} - H - CH_{2}CH_{2} - H - DFP$$
3.0 %

$$C_{3}H_{11} - H - CH_{2}CH_{2} - H - DFP$$
3.0 %

$$C_{3}H_{11} - H - CH_{2}CH_{2} - H - DFP$$
3.0 %

$$C_{3}H_{7} - H - H - CH_{2}CH_{2} - H - DFP$$
3.0 %

$$C_{3}H_{7} - H - H - CH_{2}CH_{2} - H - DFP$$
3.0 %

$$C_{3}H_{7} - H - CH_{2}CH_{2} - H - DFP$$
3.0 %

$$C_{3}H_{7} - H - CH_{2}CH_{2} - H - DFP$$
3.0 %

$$C_{3}H_{7} - H - CH_{2}CH_{2} - H - DFP$$
3.0 %

$$C_{3}H_{7} - H - CH_{2}CH_{2} - H - DFP$$
3.0 %

$$C_{3}H_{7} - H - CH_{2}CH_{2} - H - DFP$$
3.0 %

as the compounds of the formula (IV),

55

0.6 %

$$c_{3}H_{7}$$
 $-CH_{2}CH_{2}$ $-C=C$ $-C_{2}H_{5}$ 3.7 %

$$C_3H_7$$
 $C = C$ $C = C$ C_2H_5 3.8 %

as the compounds of the formula (V),

$$C_3H_7$$
 C_2H_5 3.8 %

$$C_3H_7$$
 H C_2H_5 2.0 %

$$C_3H_7 - H - O - C_4H_0$$
 3.0 %

as another compound,

40
 C_5H_{11} H C_3H_7 2.2 %

45 Claims

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 A liquid crystal composition characterized in that it contains the following first component and second component:

first component

at least one member of compounds expressed by the formula (I):

$$R_1 - (A - Z_1)_{\ell} - (B - Z_2)_m - S_1$$
 S_2
 S_3
(I)

wherein R_1 represents an alkyl group of 1 to 10C or an alkenyl group of 2 to 10C (wherein one or two not-adjacent carbon atoms in these groups may be replaced by oxygen atom, -CO- or -COO-),

 $S_1,\,S_2$ and S_3 may be the same or different, and each represent F atom, -CHF2, -OCHF2, -CF3 or -OCF3,

 Z_1 and Z_2 may be the same or different, and each represent - Z_3 -(C)_n- Z_4 - (wherein Z_3 and Z_4 may be the same or different, and each represent -COO-, -CH₂CH₂-, -CH = CH-, ethynylene group or single bond), -COO-, -CH₂CH₂-, -CH = CH-, ethynylene group or single bond,

A, B and C may be the same or different, and each represent trans-cyclohexane ring:

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(wherein one or two not-adjacent -CH2-s in this ring may be replaced by oxygen atom), or benzene ring

20 (wherein one or two or more = CH-s in this ring may be replaced by nitrogen atom, and hydrogen atom(s) in this ring may be replaced by fluorine atom(s)),

t, m and n may be the same or different, and each are 0 or 1, and $t+m+n\ge 1$), and

second component

at least one member of compounds expressed by the formula (II):

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$$R_2 \longrightarrow H \longrightarrow Z_5 \longrightarrow X_1$$
 (II)

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wherein R_2 represent an alkyl group of 1 to 10C or an alkenyl group of 2 to 10C (wherein one or two not-adjacent two carbon atoms in these groups may be replaced by oxygen atom, -CO- or -COO-), Z_5 represents -COO-, -CH₂CH₂-, -CH = CH- or single bond,

X₁ represents F atom, -CF₃, -OCF₃ or -CHF₂,

Y₁ represents H atom or F atom

(wherein, when Z_5 represents single bond and X_1 represents F, then Y_1 cannot be H atom).

 A liquid crystal composition according to claim 1, which further contains the following third component; third component

at least ore member of compounds expressed by the formula (III)

$$R_3$$
— H — Z_6 — A — Z_7 — X_2 (III)

wherein

R₃ is as defined in R₁ of the formula (I),

A is as defined in A of the formula (i),

 Z_6 represents -COO-, -CH₂CH₂-, -CH = CH- or single bond,

Z₇ represents -COO-, -CH₂CH₂-, -CH = CH-, ethynylene group or single bond,

X₂ represents F atom, -CF₃, -OCF₃, -CHF₂ or -OCHF₂, and

Y₂ is as defined in Y₁ of the formula (II).

A liquid crystal composition according to claim 2, which further contains the following fourth component,

fourth component

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at least one member of compounds expressed by the formula (IV):

$$R_4 - H - Z_8 - A - Z_9 - O - R_5$$
 (IV)

wherein R_4 and R_5 may be the same or different and each are as defined in R_1 of the formula (I), A is as defined in A of the formula (I),

Z₈ represents -COO-, -CH₂CH₂-, -CH = CH- or single bond, and

Z₃ represents -COO-, -CH₂CH₂-, -CH = CH-, ethynylene group or single bond.

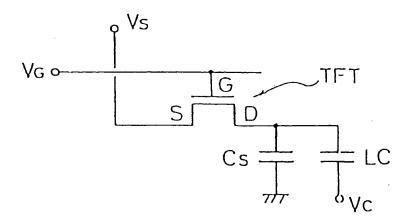
4. A liquid crystal composition according to claim 3, which further contains the following fifth component, fifth component

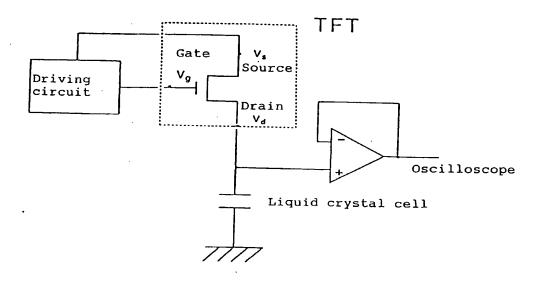
at least one member of compounds expressed by the formula (V)

R6 - A - Z10 - B - R7

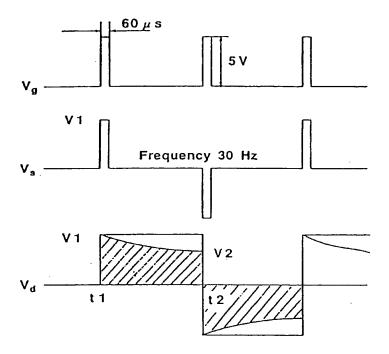
- wherein R_6 and R_7 may be the same or different, and each are as defined in A of the formula (I), B is as defined in B of the formula (I), and Z_{10} represents -COO-, -CH₂CH₂-, -CH = CH-, ethynylene group or single bond.
- 5. A liquid crystal display element obtained using a liquid crystal composition according to either one of claims 1 to 4.

F I G . 1





F I G . 2 Circuit for measurement of retention



 ${f F}$ ${f I}$ ${f G}$. 3 Wave-form at measurement of retention

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP93/01106

A. CLASSIFICATION OF SUBJECT MATTER						
Int. Cl ⁵ C09K19/42, C09K19/08						
According to International Patent Classification (IPC) or to both national classification and IPC						
	LDS SEARCHED					
	ocumentation acarched (classification system followed b					
Int.	Int. Cl ⁵ C09K19/08-19/34, C09K19/42-19/46					
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched						
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CAS ONLINE						
C. DOCU	MENTS CONSIDERED TO BE RELEVANT					
Category*	Citation of document, with indication, where a	ppropriate, of the relevant passages	Relevant to claim No.			
х	WO, Al, 91/15555 (Merck Pa October 17, 1991 (17. 10. & JP, A, 5-500679		1-5			
Y	DE, A1, 4106345 (Merck Patent GmbH), September 26, 1991 (26. 09. 91), (Family: none)		1-5			
. Y	DE, A1, 4027840 (Merck Patent GmbH), March 7, 1991 (07. 03. 91), & JP, A, 4-501575		1-5			
. Y	JP, A, 2-233626 (Chisso Co September 17, 1990 (17. 09 & EP, A1, 387032		1-5			
A	DE, A, 4111990 (Merck Patent GmbH), October 24, 1991 (24. 10. 91), & JP, A, 4-234828		1-5			
E	GB, A, 2253403 (Merck Pate	nt GmbH),	1-5			
X Furthe	r documents are listed in the continuation of Box C.	See patent family annex.				
Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance: "E" carlier document by published on or after the international filing date or other special reason (as specified) "O" document referring so as oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed international filing date but later than the priority date claimed international filing date but later than the priority date claimed international filing date but later than the priority date claimed international filing date but later than the priority date claimed international filing date but later than the priority date claimed international filing date but later than the priority date claimed international filing date but later than the priority date claimed international filing date but later than the priority date claimed international filing date but later than the priority date claimed invention cannot be combined with one or more other such document; such combination being obvious to a permos skilled in the art "E" actually the priority date of another claimed invention cannot be considered to involve as inventive step when the document is combined with one or more other such document, such combination being obvious to a permos skilled in the art						
Date of the actual completion of the international search October 22, 1993 (22. 10. 93) Date of mailing of the international search report November 9, 1993 (09. 11. 93)						
Name and m	ailing address of the ISA/	Authorized officer				
Japanese Patent Office						
Facsimile No	; · ·	Telephone No.				

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP93/01106

	•	PCT/JP93/01106		
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT				
Category*	Citation of document, with indication, where appropriate, of the rele	vant passages	Relevant to claim No	
	September 9, 1992 (09. 09. 92), (Family: none)	•		
E	JP, A, 5-105876 (Sharp Corp.), April 27, 1993 (27. 04. 93), & EP, A1, 502407		1-5	
	·			
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